ELEMENTARY EXPERIMENTS IN PSYCHOLOGY

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PREFACE

PSYCHOLOGY is now taught in several Universities and Colleges in India. Year by year the number of students registering for a course in psychology for the B.A. or B.Sc. degree is increasing and teachers in several Universities and Colleges have been feeling the need for a laboratory guide in psychology. Copies of foreign publications are difficult to obtain and generally out of reach of the majority of students. This book is written with the hope of meeting this need in the country.

In Part I the student is given an orientation to the experimental method and is introduced to the elementary statistical methods which he has to learn if he is to profit by a course in psychology. Long experience has shown me that many students who take up psychology are shy, if not afraid, of numbers. But the calculation of some elementary statistical constants does not involve any training in mathematics. Without such calculation the laboratory course will be futile, for the statistical constants aid us in reasoning and deduction, as also in planning and designing experiments. This chapter is written with the hope that students will realize the necessity and value of such training.

The experiments in Part II are the standard experiments which form part of any laboratory guide in psychology. The apparatus necessary for conducting the course is very simple. To help the instructor a list of materials necessary for the course, together with the names of some of the firms which manufacture them in different parts of the country, is given. It is hoped that the method adopted with respect to procedure and treatment of data will focus the attention of the student on the basic aspects of the problem under investigation.

Appendix A gives reference by pages to standard textbooks of psychology relevant to each chapter, so that the student may find additional information. He is advised to consult as many of these books as possible in order that he may understand the significance of the work he is doing.

In Appendix B further information is given to instructors regarding the apparatus, procedures, etc. References to original articles are given where necessary.

If teachers and students find the laboratory guide useful the author will look upon his labour as fruitful.

The experiments are designed for the ordinary two-year course in practical work, but it is advisable that students who are preparing for an Honours Degree in Psychology should be taken through this course in the first year alone. It is hoped to bring out a companion volume of additional experiments which will cover the syllabus ordinarily prescribed for Honours and M.A. courses.

My thanks are due to Sri K. R. Rajagopalan, Assistant Professor of Mathematics and Statistics of the Christian College, Madras for going through the chapter on statistics and giving valuable suggestions.

MYSORE B. K.

28 *November* 1953

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PART I

INTRODUCTORY

Chapter I

THE AIM OF EXPERIMENTAL PSYCHOLOGY

'As an experimentalist, I feel bound to let experiment guide me into any train of thought which it may justify'.

FARADAY

PSYCHOLOGY is now defined as the study of the activities of individuals. The study of individuals and their behaviour, and in particular the study of oneself and one's motives and shortcomings, is very old indeed. Folk tales and mythology show the way in which the ancients attempted to understand themselves and others around them.

The history of science shows that man was capable of studying the things around him in an objective way long before he could approach the living beings around him, and himself, in the same way. The physical sciences were the first to develop; the biological sciences followed much later. An objective study of man himself and his behaviour, and of the behaviour of other living creatures, had to wait for the development of the other branches of knowledge. It was only after man had grown accustomed to looking objectively at phenomena around him that he became capable of an objective study of himself.[1]

The scientific study of behaviour has not a long history. Until the middle of the last century the psychologist tried to obtain facts by turning his thoughts inward and observing what went on in his own mind.[2] But with the adoption of experimental methods

[1] In India an objective attitude towards the understanding and control of mental activities developed early because of the interest of Indians in the solution of the problem of evil and *samsara*. In particular the *Gita*, the Buddhistic systems and Sankhya-yoga systems have done considerable work, and reveal a marvellous insight into mental mechanisms. But the experimental and clinical approach to these problems is of recent origin in the East as well as in the West.

[2] Plato and Aristotle of Ancient Greece, Augustine and Aquinas of the Medieval period, Descartes (1595-1650), the English empiricists Hobbes (1588-1679), Locke (1632-1704), Berkeley (1685-1753) and Hume (1711-76), the associationists Hartley (1705-57), Herbart (1776-1841), James Mill (1773-1836), John Stuart Mill (1806-1873) and Bain (1818-1903), and the evolutionary associationist Herbert Spencer (1820-1903) contributed a good deal to the development of psychology on the philosophical side.

in physics, biology, physiology, and other sciences in the eighteenth and nineteenth centuries the outlook of the psychologist could not but change.

In 1811[1] Bell (England) and in 1826 Muller (Germany), two physiologists, developed the doctrine of specific energies of nerves which laid the foundation for later work in the field of sensation. About the same time (1829–34) the anatomist and physiologist Weber of Leipzig started his celebrated experiments on the measurement of thresholds in several sensory fields. In 1860 the physicist Fechner (also of Leipzig) published his *Elements of Psychophysics*, setting forth the basic methods in the field of 'mental measurement'. Wundt, the physiologist of Heidelberg, was appointed Professor of Philosophy at Leipzig in 1875, and by 1879 he had founded there the first formal psychological laboratory.[2] This brief sketch shows the great part played by physiologists and physicists in laying the foundations of the new science of experimental psychology. It also shows the importance in the history of psychology of the work done at Leipzig.

In France and later in Austria great strides were made in psychiatry and clinical psychology in the same period. As early as 1870 Richet (France) had reported that consciousness may be split, that one conscious activity may be out of contact with another conscious activity of the same person.[3] In 1878 Charcot established the clinical method in psychiatry at the mental hospitals in Paris. By 1892 Janet (France) had begun to publish his far-reaching works on hysteria. Freud (Vienna) published his papers on hysteria in 1895 and developed the psychological concepts to explain hysteria and dreams.

The third line of work which developed the objective view of behaviour problems can be traced to Darwin (England), who published his studies on emotion in 1872 and laid the foundation for the scientific study of animal behaviour. He was followed by Romanes (France), Lloyd Morgan (England) and Thorndike (America).

[1] The dates refer to significant publications by the authors named.

[2] 'This appointment brought Wundt formally into the field (philosophy) to which psychology was supposed to belong, and it brought him to it from physiology. Thus began that curious situation, which still obtains, whereby experimental laboratories grew up as adjuncts to German chairs of Philosophy.' Boring: *A History of Experimental Psychology* (Appleton-Century-Crofts, 1950), p. 323.

[3] Gardner Murphy: *Historical Introduction to Modern Psychology* (Kegan Paul, 1949), p. 169.

Darwin was also responsible for stimulating the interest of Galton (England) in the study of the problems of mental inheritance. Galton published *Hereditary Genius* in 1869, applying the statistical method to the study of individual differences among human beings. His associate Karl Pearson (England) gave the theory of correlation its present mathematical basis in 1896. Spearman took the next step in 1904 and laid the foundation of the factorial study of human ability, which has now become an important branch of psychology, through his own further work and the work of Thomson (Scotland), Thurstone (America) and others.

Galton, by his work in the 1880's, also laid the foundation of the mental testing movement. Cattell (America) had developed a number of simple tests to measure individual differences by 1890. In 1905 Binet of France first used mental tests to measure general intelligence.

Thus we find that the objective study of human behaviour is due to intellectual co-operation in several branches of study, such as physics and physiology, medicine and mathematics, in the latter half of the nineteenth century.[1] The experimental outlook in the study of behaviour problems was made possible by developments in the fields of physics, physiology, neurology and mathematics.

The Nature of the Scientific Method

The scientific method can be adopted only when we develop an 'existential' point of view. It implies that we are prepared to study the particular problem in an impersonal way. Science begins with observation and collection of facts; it aims at the increase of our knowledge concerning events. Observation implies that some hypothesis has been formed, and we observe whether the facts are in accordance with it or not; we discard the hypothesis if the facts do not support it. But every hypothesis leads to the collection of facts. Psychology is often looked upon as being divided into warring camps; this was a correct description of the state of psychology for about 20 years from 1915 onwards, but the 'schools' of psychology are now only of historical interest. The point that

[1] Reference may be made to the influence on psychology in recent years of sociology, anthropology and ethnology. The work of Malinowski, Margaret Mead, Plant, Lynd, Linton, Kardiner and others has given us a new way of looking at the problem of personality in relation to the cultural pattern.

if often overlooked is that each 'school' set up hypotheses to be tested. Whether there was agreement regarding hypotheses or not, there could be nothing but agreement regarding the facts collected in the course of testing them. Thus the very attempt to establish the 'school' on a firm foundation of facts led to its liquidation. Psychology has made tremendous strides in the last quarter of a century because of the perseverance with which psychologists have been setting up hypotheses, collecting facts to test them, and generalizing on the basis of these facts.

The aim of the present course is to help the student to collect facts himself and arrive at generalizations based on his own work. Science can be learnt not by reading books but by making observations and collecting facts in the laboratory and outside. By carrying out an experiment himself the student gains a vivid realization of the nature of the mental processes involved. It helps him to have a better knowledge of himself. Our understanding of others ultimately depends upon self-knowledge and self-analysis.

The distinguishing feature of the scientific method is the persistent desire on the part of the student to base his conclusions on the facts he has collected. He can do this only when he has a clear notion of the problem he is studying. He should direct his whole attention to solving the particular problem. This inevitably implies that he should restrict himself to a narrow problem, direct all his attention towards it, and set out definitely to control and simplify the conditions. This, in essence, is the experimental method. Simplification of the conditions, isolation, repetition and variation enable us to discover the significant causal factors. The best way of establishing a causal relationship is to introduce the condition and study its effect on the phenomenon, and then to withdraw it and find what difference its absence makes. To make one change at a time and to watch the result is the object of the 'method of difference', which is essentially the method of experiment. 'How complex or how simple is the change made depends upon the minuteness of our mental analysis of the phenomenon in question and upon our power to isolate in reality elements we have already segregated in thought.'[1] Special apparatus, instruments of precision, all help in this. But the essence of the scientific method consists not in the laboratory appurtenances but in the nature of the

[1] Welton: *Intermediate Logic* (University Tutorial Press, 1925), p. 394.

attitude towards the problem and the method of study. It is the desire to get at facts and to stick to facts in testing the hypothesis that constitutes the scientific attitude. Consequently the student must learn to work according to plan and keep a faithful record of the facts he has collected. This aspect is dealt with in the following chapter. Before turning to this problem it is necessary that the student should have a clear idea of the classification of experiments and of some cardinal rules of laboratory work.

Classification of Experiments

The experiments given in the guide may be classified into three groups. There are the *demonstrational experiments* where the instructor will be the experimenter. He will conduct the experiment on one or two students belonging to the class or on children brought specially for the purpose. The students will observe carefully the experimental set-up and record the reactions of the subject. In the *group experiments* the instructor will be the experimenter (shown as E) and the members of the class will be the subjects (shown as S or SS) undergoing the experience and working according to the instructions. In the *individual experiments* the students will work in pairs, one member acting as the subject and the other as the experimenter. After collecting and recording the data the experimenter will become the subject, so that his partner may collect data regarding his behaviour and experience. At the beginning of each experiment it is indicated whether it should be conducted as an individual or as a group experiment or merely for demonstrational purposes. But the student should never forget that he must know the apparatus and procedure thoroughly so that he can conduct each experiment on an individual or a group and collect the data to verify the hypothesis. It is best that he should go to the laboratory during his leisure hours and repeat the experiments on his friends.

General Rules for Laboratory Work

1. Do not begin the experiment till you understand the problem, the procedure and the instructions. It is essential that the purpose of the experiment and the reasons for each step in the procedure should be clearly understood. If they are not, the experiment will be conducted in a mechanical way and the value of the scientific training will be missed altogether.

2. Never vary the procedure. The results will not be comparable if there is even a minor departure from the instructions and steps in procedure. It is necessary that the student should realize that the instruction to the subject is an essential part of the experimental control of the conditions in a psychological experiment. Slight variation in the instruction may lead to a large variation in the data collected and they may be not only meaningless but positively misleading.

3. Do not look upon an experiment as a competition with your partner or other members in the class.[1] The student must clearly understand that variations in ability, sensitivity, aptitude, etc. are natural. It is the task of psychology to discover these variations. Follow the instructions and do not bother about the results. Individual differences are inevitable. The subject should never strive to obtain a certain kind of score. The reports will be falsified. Report whatever score you obtain.

4. As an experimenter, be objective. Record whatever you observe. Do not express surprise or disappointment at what the subject does. Do not feel amused when your subject struggles to cope with some task assigned to him. Such emotional expressions on the part of the experimenter are fatal to the accuracy of the results. Your emotions will affect the results. Remember that you are studying a sensitive human being. Strict objectivity is absolutely essential. Postpone discussion and scoring of the work till all the trials are completed.

5. Record the results exactly as they occur. Reliable observation is an important characteristic of the scientific method. Try to account for any irregularity in the results. Repeat the work on the same subject or on others to find whether the irregular data are due to some defects in your procedure. Remember that irregular as well as regular occurrences have their causes, so do not ignore or deny the irregularities. Record and report them; if possible, explain them.

6. Get fully acquainted with the apparatus you use and the electrical connexions. Complete knowledge of the materials you

[1] 'For the psychological experiment is not a test of power or faculty or capacity, but a dissection of consciousness, an analysis of a piece of the mental mechanism.' Titchener: *Experimental Psychology*, Vol. I, Part I (Macmillan, 1906), p. 13.

use is essential in order to follow the steps in the procedure. Do not depend helplessly on the mechanic or attendant. Remember that you can do what he can do, provided you try hard. Report to the instructor promptly if any accidental injury is done to the instruments you are working with. Help in rectifying it.

7. In a number of experiments the stimulus material should be concealed from exposure till the appropriate moment arrives. Remember that the stimulus value will be lost if the material is accidentally exposed in advance. Your results will not be valid.

8. After an experiment is completed ask your instructor which experiment will be taken up next. Study the references given and acquaint yourself thoroughly with the problem and procedure before you go to the next class. Prepare the necessary tabular forms for recording observations and introspections. This will help you to assimilate the course thoroughly. Never go unprepared to the class and thus waste your own and the instructor's time.

To sum up the mental qualities which are needed for the successful application of the scientific method, I cannot do better than to quote Francis Bacon's description of himself:

'For myself I found that I was fitted for nothing so well as for the study of Truth; as having a mind nimble and versatile enough to catch the resemblance of things (which is the chief point), and at the same time steady enough to fix and distinguish their subtler differences; as being gifted by nature with desire to seek, patience to doubt, fondness to meditate, slowness to assert, readiness to reconsider, carefulness to dispose and set in order; and as being a man that neither affects what is new nor admires what is old, and that hates every kind of imposture. So I thought my nature had a kind of familiarity and relationship with Truth.'

Chapter II

THE FORMAL REPORT

The presentation of the data of experiments in a standard form is an essential part of scientific training and work. Preparing a report of the experiment is as important as the conducting of the experiment itself. The report indicates the actual procedure adopted in the experiment so that it is open to verification. The student must remember that no conclusion has any value unless it is verified by other investigators using the same procedure. Hence the need for a meticulous description of the procedure adopted. Further, the conclusions drawn can be checked by the data presented in the report. The independent reader can judge for himself whether the conclusions drawn by you are fully supported by the data you have collected.

Consequently, at the very beginning of the course, the student must realize the importance and full significance of punctually writing up the records. The report should be submitted to the instructor within a week after the experiment has been completed. This will not only facilitate the work of the instructor but it will also make the course very fruitful as training in scientific work.

In essentials, the report of the experiment takes the same form whether it is prepared by the student for submission to the instructor or by the research worker for publication in a scientific journal. The form of the report should be as follows:

1. Title. The name and number of the experiment, the date of its performance, a statement whether it is a group experiment or individual experiment; if the latter, the name of the subject should be given. It is very necessary that the title should be properly chosen. It should express clearly and fully the nature of the experiment.

2. Problem. In a clear and brief way the purpose of the study or the working hypothesis to be tested must be set down. A clear understanding of the problem, its nature, and the way in which it is going to be studied is of the essence of scientific work. No

attempt should ever be made to start an experiment unless there is a clear understanding of its purpose.

3. Apparatus. Under this head the materials used in the experiment should be listed. If electricity is used, draw a diagram showing the wiring.

4. Procedure. The way in which the experiment will be conducted should be described next. In a clear manner each step involved in the work should be noted. Further, the instructions to be given to the subject and the conditions under which the experiment is conducted should be noted. This will enable any person to check and verify the results by repeating the experiment in the same manner.

5. Results and Discussion. In this section of the report the entire data collected should be given. The quantitative results should be given in the form of tables and graphs. The tables should be given clear and expressive titles, as also the columns in each table. The qualitative data and the introspective reports should be given next. The qualitative data answer the question, 'What kind of mental processes occurred?' and the quantitative data answer the questions, 'How often?', 'How much?' and so on.

Next the data should be analysed. There should be a complete and accurate discussion of the results obtained. Calculate the possible statistical constants and check their reliability by using the appropriate formulae and tables. The results must be interpreted in the light of the relevant matter in the textbooks; apparent inconsistencies should be explained, and any shortcomings in the procedure should be noted. The most important thing is a critical study of the results.

6. Conclusions. This part indicates the generalizations based on the data of the experiment. They should be brief, precise and numbered. The student should take care to see that the statements in this section are fully warranted by the data presented and discussed in the last section. These conclusions are answers to the questions raised in the statement of the problem.

7. Reference Work. At the end of each experiment reference should be made to the relevant chapters in the textbooks. These references are indicated in the text itself. Some of them, and any

others suggested by the teacher, should be gone through and summarized in this section. This will enable the student to compare his class work with the standard results reported by the authors.

The arrangement of the formal report of each experiment should follow the outline given below:

Individual/Group experiment Date/No. of experiment

Title of Experiment

Name of S

Problem

Copy from the text.

Materials

List materials used and draw diagram of connexions wherever necessary.

Procedure

Describe the steps followed and the instructions given to S.

Results and Discussion

Arrange the quantitative data in tables and graphs with appropriate tables. Then note the discussions.

Conclusions

Brief, precise and numbered.

Reference Work

Give a summary of the methods and results given in the textbooks with the names of the experimenters.

Chapter III

STATISTICAL METHODS

The quantitative data obtained in an experiment must be arranged and systematized, using certain statistical techniques, before their importance can be grasped. Such a treatment will reveal trends in the data which could not have been comprehended by merely looking at the 'raw' data. Furthermore, various important generalizations are suggested by such treatment.

1. *Frequency Distribution*

The first step in the systematic presentation of data is to group the measures in a *frequency table*. The following scores were obtained in a tapping test:

57, 56, 62, 68, 58, 68, 69, 44, 51, 56, 52, 60, 60, 58, 59,
65, 64, 65, 64, 58, 63, 68, 68, 68, 51, 42, 47, 75, 81, 88,
83, 63, 69, 67, 64, 56, 52, 55, 58, 74, 73, 62, 73, 75, 63,
62, 62, 63, 61, 60, 70, 69, 69, 72, 70, 70, 76, 78, 71, 78.

Mere inspection of these rows of figures will reveal very little. We can simply note that the scores vary considerably and that the lowest score is 42 and the highest 88. Each score is a *variable*. The difference between the largest value of the variable and the smallest value of the variable is called the *range*. Here the range is $88 - 42 = 46$.

In order to know something more about these scores we must group the variables into classes. This produces what is called a *frequency distribution table*, and from it we can find the frequency with which a given score occurs. For example, inspection shows that the score 57 has occurred only once in the whole distribution, so its frequency is 1. Score 56 occurs 3 times, giving a frequency of 3. We can thus find how frequently any score or variable occurs. We can discover something more if we find the frequency of a group or class of scores rather than that of a single score. Table I shows how this can be done. In order to draw up a frequency table we must first determine the *class interval*, the interval between the classes into which we decide to distribute the scores.

The decision as regards the number and size of the classes will depend upon the range and the kind of measures with which we are concerned. The best general rule is to select by trial a class interval which will yield not more than 20 and not less than 10 classes. If the range is divided by the number of classes decided upon we get roughly the size of the interval. The most convenient thing is to employ round numbers such as 5 or 10 as the size of the interval. This facilitates further calculations.

TABLE I

Frequency Distribution

Class Interval	*Tally*	*f*
41 - 45	||	2
46 - 50	|	1
51 - 55	𝍸	5
56 - 60	𝍸 𝍸 ||	12
61 - 65	𝍸 𝍸 ||||	14
66 - 70	𝍸 𝍸 |||	13
71 - 75	𝍸 ||	7
76 - 80	|||	3
81 - 85	||	2
86 - 90	|	1
Total		60

After writing down the class intervals comes the work of *tabulation*. This is done as indicated in the 'tally' column in the table above. Each score is taken and a mark is made opposite the appropriate interval. For the first score, 57, a mark is placed opposite class 56–60, and so on till all the scores are entered. The scores are tabulated in the order in which they occur, and the fifth mark is drawn horizontally across the previous four, in order to show the groups of five clearly, and thus facilitate counting up.

The marks are finally added and entered in the *f* column (the column showing the frequency).

2. *Graphic Representation*

A further aid in analysing the numerical data is the graphic treatment of the material. Graphic representation gives a visual picture of the distribution as a whole. It helps us to perceive readily

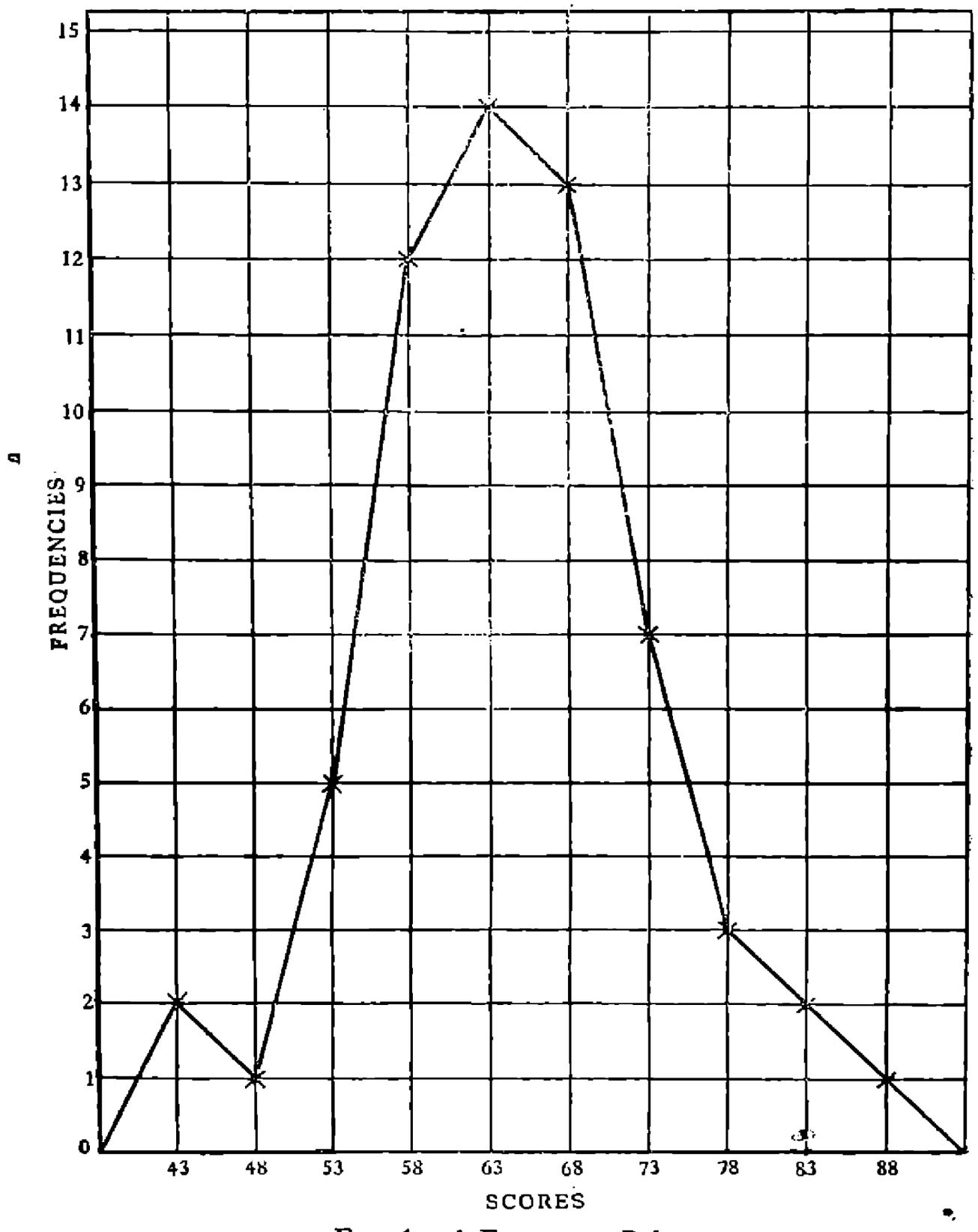

FIG. 1. A Frequency Polygon

the trends of a distribution as a whole and the detailed variation from one part of the distribution to another. Fig. 1 represents the data in Table I. This is called a *frequency polygon*. To prepare this a cross-section paper is required. Mark all the class intervals along the horizontal axis (called the x axis). In plotting a frequency polygon we must remember that the 'midpoint' of the interval is taken to represent all the scores within that interval; thus the class interval 41–45 is represented by 43. At the left-hand end of the base line erect the vertical axis (the y axis). Divide the y axis into units so that the greatest frequency occurs at the top. Mark along this axis the units of frequency. Fix the co-ordinate points by going up along each class interval (point in x axis) according to the frequency in the interval. When these points are joined in a regular order we obtain the outline of the frequency polygon. In order to complete the figure, the frequency of the class below the lowest (36–40) and that of the class above the highest (91–95) are both taken as zero, and consequently the frequency polygon begins and ends on the x axis. The total frequency (N) of the distribution is represented by the *area* of the polygon.

Another method of graphic representation is by drawing a *column diagram* or *histogram* (Fig. 2). When we have a discontinuous series of scores, however, a *bar diagram* will be a better way of representing the data. In several social studies we obtain percentages for various classes of groups; these can be represented as separate rectangles or bars whose heights give the amount of the given attribute present.[1] The bars are separated, not contiguous like the columns of a histogram; they should be equidistant and arranged according to ascending or descending rank order. On the y axis the incidence of the attribute will be indicated and on the x axis the description of each group.

3. *The Normal Curve of Distribution*

The frequency distribution reveals a certain degree of orderliness in the data. This becomes clearer if we observe Fig. 1. We notice that the frequency at the lower and higher extremities is less than in the middle range. There is a tendency for the intervals near the centre of the distribution to contain a large number of scores. Thus the polygon is approximately bell-shaped. The scores

[1] For example, in Exp. 34 the strength of the various fields of imagery can be represented by a bar diagram.

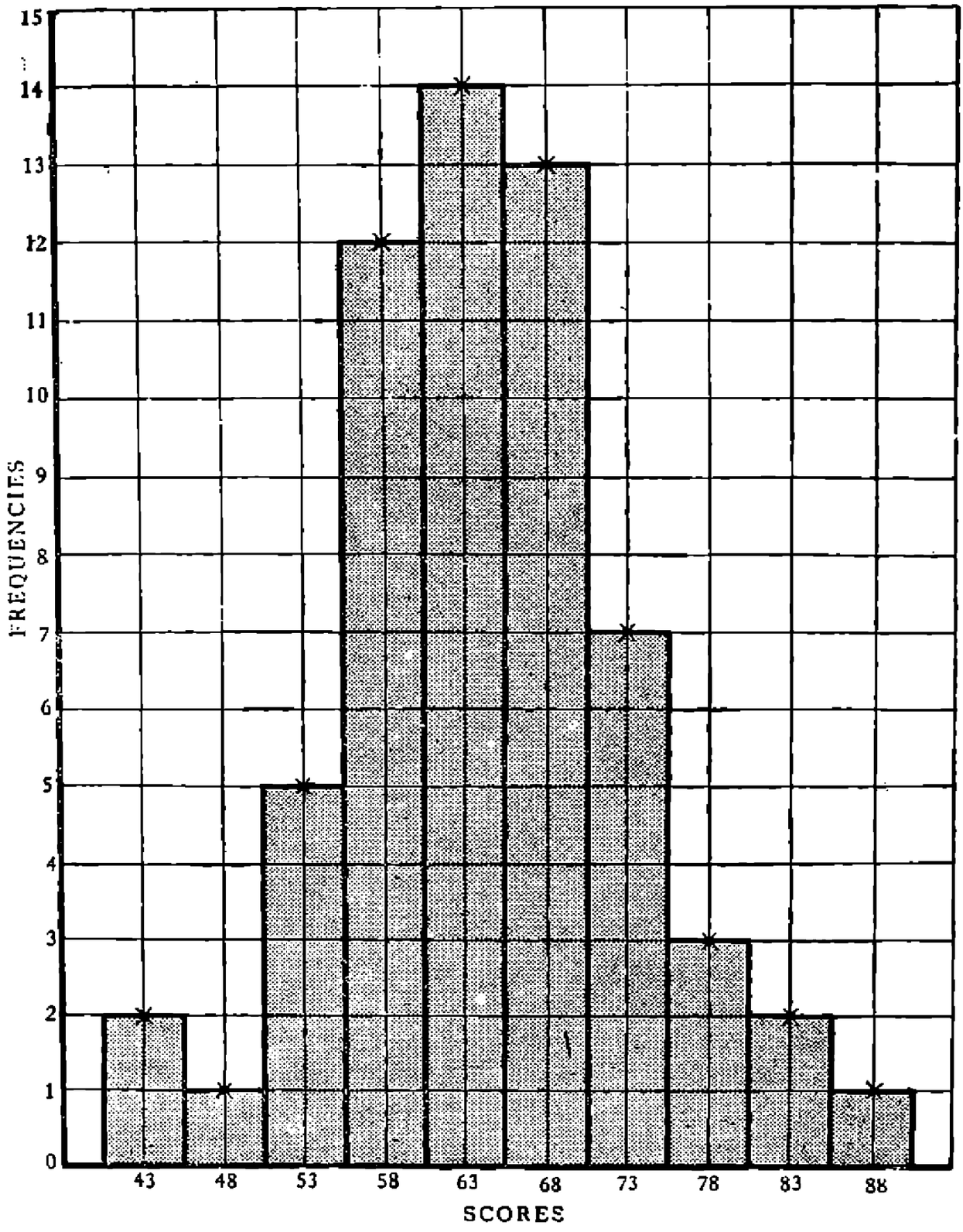

FIG. 2. A Column Diagram or Histogram

tend to pile up near an average ability at the centre of the distribution and to thin out towards the extremities, to the right as well as to the left. The irregularity and lack of symmetry of Fig. 1 is due to the fact that the scores plotted are few. If instead of 60 cases we had taken six hundred or more we would observe that the graphic outline becomes much more regular and symmetrical.

So we can assume that if an infinite number of scores were taken into account the distribution would be perfectly symmetrical. Fig. 3 shows such a curve, which is the theoretical 'normal' curve of distribution. In psychological measurements, as in many other fields, we notice that the frequency distributions approximate to this normal curve. In general, the larger the group the greater is the approximation to the theoretical curve. Further, the more 'random' the sample (i.e. the more representative it is of the

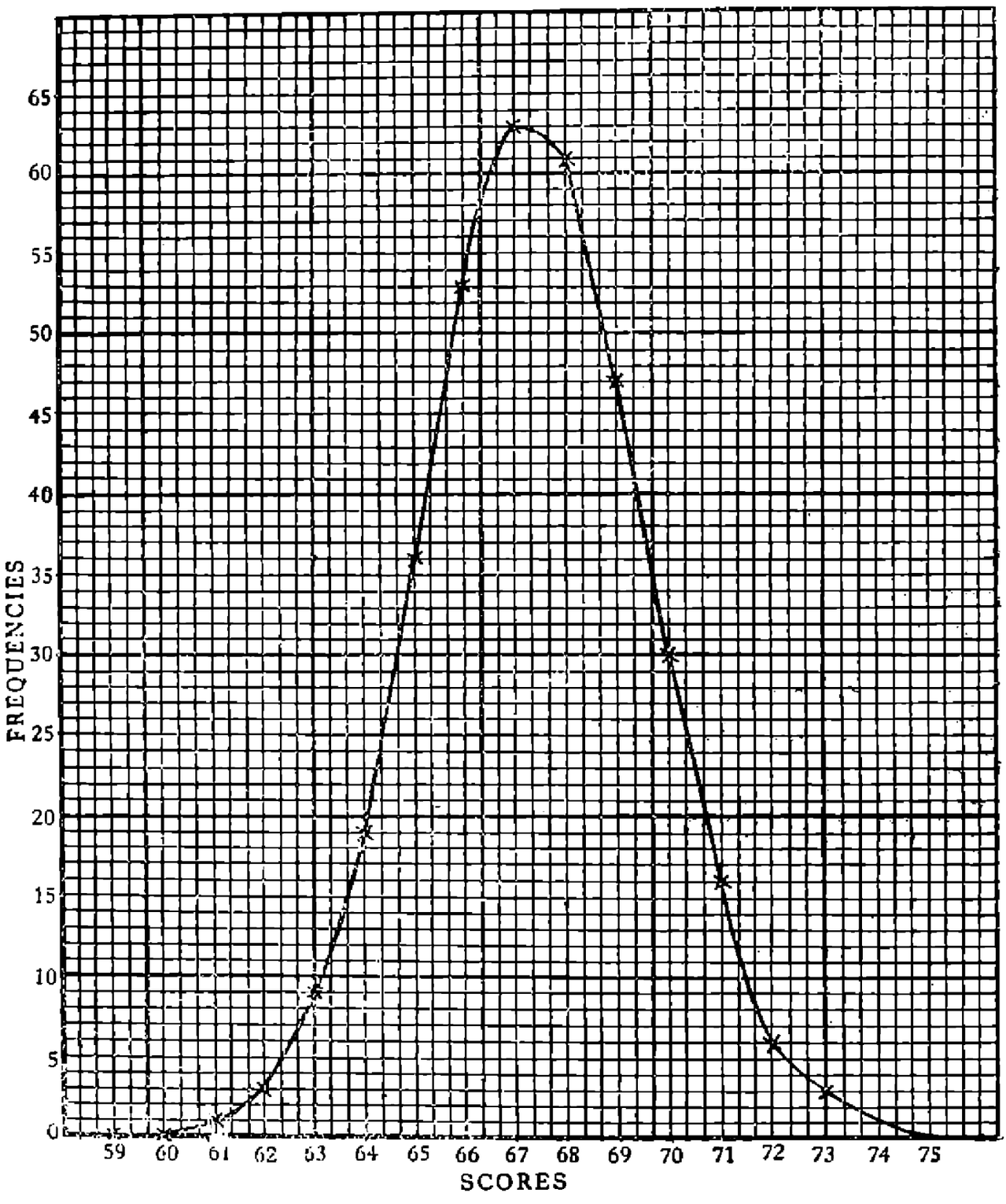

FIG. 3. The Normal Curve of Distribution

group as a whole) and the less the element of selection, the greater its approximation to the theoretical curve. This is the reason why, whenever we make an attempt to measure a certain ability, we should take not only as many cases as possible, but also see that they are, as far as possible, representative of the group as a whole rather than of any selected sample.

There are two important properties of a normal probability curve that we should constantly bear in mind. The first is that the highest point of the curve is right in the centre. As we shall soon see, this is called the *central tendency* or the *average*. We observe that in the normal frequency curve the average falls exactly at the middle point of the distribution. The second feature is that the two sides are absolutely symmetrical. The area of the right half is exactly the same as the area of the left half. The number of scores more than the average is exactly equal to the number of scores below the average. In other words, the *variability* above the average is similar to the variability below the average. On the basis of these two features of the normal frequency curve arises that well-known property of distribution, namely that the largest number of scores cluster around the centre, thus giving the curve the characteristic bell shape.

4. *Measures of Central Tendency*

We have seen that the frequency polygon gives a visual representation of the distribution. With the help of statistical methods we can also get a numerical representation of the distribution. Two kinds of representative numerical values may be computed: (i) measures of central tendency or averages; (ii) measures of variability.

There are three methods of computing the average or central tendency: the *mean*, the *median* and the *mode*. As we have seen above, the scores in a distribution tend to cluster round the centre. Consequently a measure of the *central tendency* will give us a condensed description of the entire distribution. The typical performance of the group as a whole is now indicated by a single value. The most familiar average is the arithmetic *mean*, which is calculated by *adding all the scores and dividing the total by the number of scores*. The formula for computing the mean is $M = \frac{\Sigma x}{N}$ in which M is the Mean, Σx is the sum or total of the

individual measures or scores, and N is the number of measures or scores in the series. Table II illustrates the procedure for ungrouped data.

TABLE II

Computation of the Mean

Scores	
8	$\Sigma x = 96$
9	
5	$N = 11$
10	
10	
11	$M = \frac{\Sigma x}{N}$
9	
6	
9	$= \frac{96}{11}$
7	
12	
—	$= 8.7$
96	

If the scores are arranged in a frequency table a slightly different procedure is necessary. In the frequency table the figures indicate the numbers of times scores within a given class interval occur. It is assumed that the scores within a class interval are distributed evenly throughout the entire distribution within the interval. In order to compute the sum of scores (Σx) the frequency of each class interval should be multiplied by the midpoint of that interval and the resulting figures should be added together. This process is less laborious than adding up all the scores in a distribution involving hundreds or thousands of cases.

But there is another process which involves less arithmetic than this. The most convenient and quick method of calculating the mean is to assume or guess a mean which is somewhere in the middle of the distribution, e.g. the midpoint of the class interval which comes in the middle of the distribution. A correction has to be applied to it in order to obtain the true mean. When the true mean is arrived at, the positive deviations (or the sum of the deviations from the mean of the scores more than the mean) will equal the negative deviations (or the sum of the deviations from the mean of the scores less than the mean). Since we have assumed a mean, it may or may not be correct. If it is correct there will be no difference between the sum of the positive deviations and the sum of the negative deviations; if it is not correct there will be a difference. In order to get the true mean the average of this

difference will have to be algebraically added to the guessed mean. This is the logical process involved.

To compute the mean we should first of all assume a mean. Then the deviations (d) will have to be written. Table III below shows how this is done. Each class interval is now treated as a unit. 63 is the guessed mean; so the deviation for the class interval 61–65 is zero. The class interval 56–60 deviates from the class interval 61–65, which contains the guessed mean, by one unit

TABLE III

Computation of the Mean and Standard Deviation of Grouped Data

Scores	*Midpoint*	f	d	fd	d^2
41–45	43	2	−4	− 8	32
46–50	48	1	−3	− 3	9
51–55	53	5	−2	−10	20
56–60	58	11	−1	−11	11
				−32	
61–65	63	15	0	0	0
66–70	68	13	1	13	13
71–75	73	7	2	14	28
76–80	78	3	3	9	27
81–85	83	2	4	8	32
86–90	88	1	5	5	25
		N = 60		49	197

Guessed Mean = 63 $\quad \Sigma fd = 49 - 32 = 17$

$\Sigma fd^2 = 197$

Correction in terms of class interval (c) $= \dfrac{\Sigma fd}{N} = \dfrac{17}{60} = 0.28$

Correction in terms of score (C) $= 0.28 \times 5 = 1.40$

Mean = Guessed Mean + C $= 63 + 1.40 = 64.40$

Standard Deviation (SD) $= \sqrt{\dfrac{\Sigma fd^2}{N} - c^2} \times$ class interval

$= \sqrt{\dfrac{197}{60} - (0.28)^2} \times 5$

$= \sqrt{3.2833 - 0.0784} \times 5$

$= 1.79 \times 5$

$= 8.95$

(class interval), and it is less; so -1 is entered against it. In this way the deviations of all the class intervals from the guessed mean are put as positive or negative according to whether their midpoints are greater or less than the guessed mean. Next each deviation (*d*) is multiplied by the frequency (*f*) of the class interval in order to get *fd*. The sum of all the positive *fd* and the sum of all the negative *fd* are now found and the difference between the two is divided by N, the number of cases. The value is the correction (*c*) with class interval as the unit. This should be multiplied by the class interval to obtain C, the correction in score units, and this should be added to (or, if C is negative, subtracted from) the guessed mean in order to obtain the true mean (see Table III).

Another measure of central tendency that is frequently used in psychology is the *median*. It may be defined as *the central score when the scores are arranged in order of magnitude*. It divides the scores into two equal groups, one half being above and the other half below the median. The first step in computing the median is to arrange the scores in order of magnitude, add one to the number of scores and divide the sum by 2: $\frac{(N+1)}{2}$. Given an odd number of scores we get a whole number. In Table IV (*a*) below we get $\frac{11+1}{2}$, that is, 6. This means that the sixth score in Table IV (*a*) is the middlemost or median; in the present case it is 9. The same procedure applied to an even number of scores as in Table IV (*b*) will not give us a whole number. In this case it is $\frac{10+1}{2}$, i.e. 5.5, which means that the median lies between the fifth and

TABLE IV

Computation of the Median

(*a*)

5
6
7 N = 11
8
9
9
9 $\frac{(N+1)}{2} = \frac{11+1}{2} = 6$
10
10
11
12 ∴ Median = 6th score = 9

(*b*)

6
7 N = 10
8
9 $\frac{(N+1)}{2} = \frac{(10+1)}{2} = 5.5$
9
9
10 ∴ Median = average of the 5th
10 and 6th scores
11
12 $= \frac{9+9}{2} = 9$

sixth scores. Then the value is obtained by adding the values of the two middlemost scores and dividing the sum by 2; in this case also the answer is 9.

A third measure of the central tendency is the *mode*. It is defined as *the most frequently occurring value* in the distribution. In the above series the most often recurring measure is 9. This is consequently the mode in this distribution. This is the measure implicit in our judgments of, for instance, the height, complexion, etc., of people from the various parts of India. We look upon Punjabis as tall and South Indians as short because we frequently come across tall men among the Punjabis and short-statured men among the South Indians.

All these three measures—the mean, the median and the mode —give us a condensed description of the entire distribution. They give us a value which is typical or representative of the set of scores as a whole. But this is only one aspect of the distribution. There is also the other aspect, the *variability*, otherwise known as the 'scatter' or the 'spread' of the scores.

5. *Measures of Variability*

These measures indicate to what extent the scores in a distribution vary or differ from one another. They give us an indication of whether the scores are homogeneous or not; if they are homogeneous they will be very close to each other, otherwise they will be 'scattered'. There are four methods by which the variability can be measured.

The most simple measure of variability is the *range*. We have used the concept of range already (p. 13) in the preparation of the frequency table. As we saw, it is the *interval between the largest and the smallest measures*. In Table II all the scores vary between 5 and 12. The range is thus $12-5=7$. This is the most general measure of the 'spread' or distribution. It is employed when we wish to make a rough comparison between two or more groups, or when the number of measures is too small to apply the more refined and elaborate methods. It is obvious that it is not a very reliable measure of variability since it takes into account only the extremes of the series. It becomes particularly unreliable when there are gaps in the distribution.

A second method of calculating the variability is the *quartile*

deviation (Q). It may be defined as *half the distance between the 75th and 25th percentile points* in the distribution. There are three points which divide a distribution into four quarters, i.e. 25%, 50% and 75%, written Q_1, Q_2 and Q_3. As we have seen above, Q_2, which has half the scores above it and half below, is the median. Now Q_1, in a table of scores in descending order of magnitude, has one quarter or 25% of the scores above it and three quarters or 75% of the scores below it; similarly Q_3 has three quarters or 75% of the scores above it and one quarter or 25% of the scores below it.

In order to find out which score represents Q_1 we add one to the number of cases and divide by 4. This gives us the position of Q_1 in the table. By multiplying this figure by 3 we get the position of Q_3. Table V below illustrates the procedure. $\frac{N+1}{4} = \frac{11+1}{4} = 3$. Q_1 is thus the third score, i.e. 7; Q_3 is the ninth (3×3) score, i.e. 10. Half the difference between the two values is the Quartile deviation (Q). Q is also called the *semi-interquartile*

TABLE V

Computation of Quartile Deviation

Scores	
5	$N = 11$
6	$\frac{N+1}{4} = \frac{11+1}{4} = 3$
7	$\therefore Q_1$ is the third score $= 7$
8	Q_2 is the sixth score (median) $= 9$
9	
9	Q_3 is the ninth score $= 10$
9	
10	$\therefore Q = \frac{Q_3 - Q_1}{2} = \frac{10-7}{2} = 1{\cdot}5$
10	
11	
12	

range as it is half the interquartile range, the difference between the first and third quartiles. It is a measure of the average distance of the two quartile points from the median. Thus Q measures the closeness with which the scores are grouped around the median point. If the scores are packed closely around the median the quartiles will be very near each other and Q will be small; if the scores are scattered the quartiles will be far apart and Q will be large.

It is obvious that this measure is more reliable than the range because it takes into account the quartiles. But this method of

calculating the variability is also a rough one. It does not take into account the variability of the individual scores but only the difference between the two scores which occupy the quartile position. This method is quite satisfactory as a rough estimate. It is also quite enough for the small distribution that students come across in their class work. But when an accurate measure of variability is needed we must use other methods.

A third method used in measuring the variability is the *average deviation*, or AD (also known as *mean deviation* or MD). It may be defined as *the average of the deviations of the individual measures from the central tendency*. These deviations are generally calculated using the mean. In finding the average of the deviations we neglect the plus and minus signs; in other words, we take into account only the size of the deviation and disregard the direction of deviation, whether positive or negative. We first find the mean and then calculate the difference between each score

TABLE VI

Computation of the Average and Standard Deviation of Ungrouped Data

Scores	d	d^2
6	3	9
6	3	9
8	1	1
9	0	0
9	0	0
9	0	0
10	1	1
10	1	1
11	2	4
12	3	9
$\Sigma x = 90$	$\Sigma d = 14$	$\Sigma d^2 = 34$

$$N = 10$$

$$M = \frac{\Sigma x}{N} = \frac{90}{10} = 9$$

$$AD = \frac{\Sigma d}{N} = \frac{14}{10} = 1.4$$

$$SD = \sqrt{\frac{\Sigma d^2}{N}} = \sqrt{\frac{34}{10}} = \sqrt{3.4} = 1.84$$

and this calculated mean (d). Next we must add up all these differences or deviations from the mean to find the sum of deviations (Σd). Σd divided by N (number of scores) gives AD, the average of all the deviations, positive or negative, from the

mean. In Table VI we find that the sum of deviations is 14 and the average deviation is $\frac{14}{10} = 1.4$.

This method takes into account each score in arriving at a measure of the variability. Thus it is superior to the other two measures we have so far seen. But it suffers from the fault that it neglects the direction of deviation as it puts together the positive and the negative deviations. This defect is overcome by the next method of calculation, the *standard* deviation, which eliminates the plus and minus signs by squaring each deviation. Next the sum of the squares (Σd^2) is found (see Table VI), and is divided by the number of scores to obtain the average of d^2; finally, the square root of this is calculated to arrive at the standard deviation (SD)—denoted by the symbol σ (sigma).

The preceding paragraph refers to ungrouped data. For the method of finding the standard deviation of grouped data we must return to Table III on p. 21. In order to obtain the correction which has to be applied to the guessed mean to get the true mean, we found the deviations from the guessed mean in terms of class intervals (d), and multiplied them by the frequency of each interval to get the fd. The next step is to multiply each fd by d to obtain fd^2 values, and then to add up the sum of the squares (Σfd^2). This is divided by N to give the average fd^2 and from this c^2, the square of correction in terms of class interval as unit, must be subtracted. The square root of the result gives us the SD in units of class interval, and when this is multiplied by the size of the class interval we obtain the SD in score units. This is a very accurate measure of the variation since it takes into account the deviations of each score from the central tendency. Furthermore, it is amenable to algebraic treatment which gives us the standard error and other statistical constants.

In the normal probability curve the three measures of central tendency will coincide, and the value of the mean will be the same as the value of the median and the mode. Another property is that the entire distribution can be obtained by laying off three standard deviation lengths on each side of the mean. In Table VI the mean is 9 and SD is 1·8. If we add to this $3 \times$ SD we get the highest value of the distribution ($9 + 3\ (1{\cdot}8) = 9 + 5{\cdot}4 = 14{\cdot}4$), and if we subtract $3 \times$ SD from the mean we get the lowest value of the distribution ($9 - 5{\cdot}4 = 3{\cdot}6$). In other words all the values in the

distribution will lie between the limits $M-5{\cdot}4$ and $M+5{\cdot}4$. This is the reason why in a scientific report, instead of giving all the 'raw' data or the frequency table, the author will merely give the central tendency and the measure of variability.

Thus the measure of central tendency and the measure of variability between them give us a picture of the entire distribution.

6. *The Comparison of Groups*

We use these measures in order to compare two groups of individuals who do the same work. The difference between the two measures of central tendency will indicate the difference in performance between the two groups. The measure of variability will show which group is more concentrated around the central tendency and which group has a greater scatter. As we have already observed, in the distribution with a smaller measure of variability scores cluster around the central tendency and the opposite occurs when the variability is greater.

But comparing the absolute measures of variability in the above manner may not give us a correct picture of the variability. We can compare them directly by computing the relative variability or the *coefficient of variability*. Let us suppose that in a tapping test group A ($N=100$) makes the mean score of 100 with an SD of 15, and group B ($N=100$) obtains a mean score of 95 with an SD of 12. Straightaway we can say that group B is inferior to Group A since there is a difference of 5 taps in the average score. We can also observe that the 'spread' in group A is more than the 'spread' in group B—as the SD of A is three units more than the SD of B. Even when there is a difference between the SD in the two cases we cannot be quite sure about our inference regarding the difference in variability since the mean in each case is also different. As we know, the measure of variability is obtained on the basis of the central tendency for the group. In order to make a strict comparison we should reduce the two SD to the same terms by computing the coefficient of variability. This we can obtain by using the formula $V=\frac{100\times SD}{Mean}$, where V is the coefficient of variability. Applying this formula we find that, for group A $\left(\frac{100\times 15}{100}\right)$, $V=15$, whereas for group B $\left(\frac{100\times 12}{95}\right)$ it is 12·63. Thus we can now say that the measures in group B

concentrate around its central tendency to a greater extent than they do in group A. In other words, though the general performance of the individual in group A is superior to that of group B, the latter group is more homogeneous. The coefficient of variability is particularly useful when we are comparing the performance of the same group under different conditions.

As we have seen, group A is superior to group B because the mean score for A is 100 taps whereas for B it is only 95. Are these measures reliable? Is the difference between the two groups a significant difference? If the measures cluster closely around a single value, the chances are that similar series of measurements will give the same or very nearly the same distribution. In other words, the greater the variability the less the reliability or dependability of the measures of central tendency. Thus the reliability of an obtained average has an *inverse relationship* with the measure of variability of the distribution. Its reliability, i.e. whether the same mean or a closely similar mean will be obtained on another occasion, will depend upon the scatter of the distribution. It also depends on the number of measures obtained. Within limits, the greater the number of measures on which the mean is calculated the greater the reliability of the mean. Indeed, the reliability increases not in proportion to the increase in the number of measurements but in proportion to the square root of that number. The reliability of the mean or whatever measure we have computed depends upon two factors: the variability of the distribution and the number of cases involved.

We can find out whether the mean or SD that we have obtained is a reliable one by calculating the *standard error* of that value. Standard error of mean $(\sigma M) = \frac{SD}{\sqrt{N}}$. The standard error of the mean for group A is $\frac{15}{\sqrt{110}} = \frac{15}{10} = 1.5$ and for group B is $\frac{12}{\sqrt{100}} = \frac{12}{10} = 1{\cdot}2$. This means that as far as the mean of group A is concerned the chances are more than 2 out of 3 (for $\pm 1\sigma$ M includes 68·26% of the cases) that the true average lies within the limits $100 = 1{\cdot}5$ and $100 + 1{\cdot}5$, i.e. between 98·5 and 101·5; and there is very little probability of the true mean falling outside $\pm 3\sigma$ M, i.e. outside the limits of 95·5 and 104·5. Similarly, when we consider the mean of group B as the basis, there is very little probability of the true mean falling outside $95 + 3$ (1·2), i.e. 91·4 and 98·6.

How reliable is the difference between group A and group B? In other words, assuming the two groups are typical, i.e. random and unselected, to what extent can we be certain that the obtained difference between the two means will occur when we take another set of samples from the two groups? Is the obtained difference statistically significant? This can be found by calculating the standard error of difference, which equals $\sqrt{SE^2_A + SE^2_B}$, and the ratio $\frac{\text{actual difference}}{\text{SE of difference}}$ or the critical ratio (CR). In the given case the SE of difference $= \sqrt{1{\cdot}5^2 + 1{\cdot}2^2}$ or 1·92. Consequently the CR is $\frac{5}{1{\cdot}92}$ or 2·6. This is significant at 5 % level. In other words, on some occasions group A may be inferior to group B. The SE of difference is 1·92. Consequently the difference between the two groups may be anywhere between $5-3$ (1·92) and $5+3$ (1·92) or anywhere between $-0{\cdot}24$ and 10·76; i.e. group B may be better than group A on some occasions. If the CR is 3 or more we can assert that the chances are very great that the true difference between the two groups will always be greater than zero.

7. *Correlation*

So far we have seen how to calculate the statistical constants which give a condensed description of the distribution (measures of central tendency and variability) and those which help us to compare the performance of two different groups when they are given the same task under identical or different conditions. Now we can learn how to compute the statistical constants which inform us how the same group performs two different tasks. What, for instance, is the relationship between marks in English and marks in arithmetic of the individuals in one group? Does a high rank in English go with a high or with a low rank in arithmetic? Or is there no relationship whatever between the two? If we can determine this then we can predict with the help of a *regression coefficient* the performance of an individual in the second task when we know his performance in the first task. The method of correlation helps us to calculate the relationship and predict. Correlation is a statistical device for finding out the extent to which scores of standing in one series of measurements may be predicted on the basis of known scores or standing in another series.

The coefficient of correlation varies from perfect positive correlation (1·00), through zero correlation, which indicates no

correspondence whatever between the two measures, to −1·00 correlation indicating perfect negative relationship. In the perfect positive correlation the person who gets the highest marks in English also gets the highest in arithmetic, the person who gets the second highest marks in English gets the second highest in arithmetic, and so on. When the person who gets the first place in English gets the last place in arithmetic and the one who gets the second place in English obtains the last but one place in arithmetic, and so on, we have the perfect negative correlation. Finally, when there is no relationship at all between standing in English and standing in arithmetic we have the zero correlation. Zero correlation or low correlation around zero means that the two variables are not related. If the position in one is high the position in the other may be high, average or low—we cannot tell. In psychological measurements we seldom get negative correlations or perfect positive correlations.

The simplest way of computing the coefficient of correlation is by employing the method of *rank differences*, using the formula:

$$\text{Rho } (\rho) = 1 - \frac{6 \Sigma D^2}{N (N^2 - 1),}$$

where Rho is the coefficient, ΣD^2 is the sum of the squares of the differences in rank between the two series and N is the number of cases in the sample. To compute Rho, arrange the scores in the two tests in two columns and put down the rank of each individual in

TABLE VII

Computation of Correlation by the Rank Difference Method

Person	*Score in Test* A	*Score in Test* B	*Rank in Test* A	*Rank in Test* B	D	D^2
A	20	14	1	2	1·0	1·00
B	17	16	2·5	1	1·5	2·25
C	17	12	2·5	3	0·5	0·25
D	15	10	4	5·5	1·5	2·25
E	14	11	5	4	1·0	1·00
F	13	9	6	7	1·0	1·00
G	10	8	7	8	1·0	1·00
H	8	10	8	5·5	2·5	6·25
						15·00

$N = 8$. $N^2 = 64$. $\Sigma D^2 = 15{\cdot}00$

$$\therefore \text{Rho} = 1 - \frac{6 \times 15}{8 \times 63} = 1 - \frac{90}{504} = 1 - 0{\cdot}18 = 0{\cdot}82$$

each test in the next two columns. When two or more persons obtain the same score in one test they must get the same rank, so the average of the ranks is given to each. Next enter in the D column the difference between the ranks for each person and in the D^2 column the square of the difference. Add up these squares to find ΣD^2.

The rank difference method is quite adequate when N is small, say less than 30. It indicates the presence of relationship rather than its extent. When the number of cases is large and when we want an accurate measure of the relationship we must compute the coefficient of correlation by the *product-moment* method. The rank difference method takes account only of the *position* of the items in the series. The product-moment method, indicated by the symbol r, takes account of both the size of the score and its position in the series. It is, however, a complicated method; it involves calculating the deviation from its mean for Test I and the deviation from its mean for Test II, squaring these deviations to find the sum of squares, finding the product of corresponding deviations for each person, and applying the formula:

$$r = \frac{\Sigma\, xy}{\sqrt{(\Sigma x^2)} \times \sqrt{(\Sigma y^2)}}$$

The method of calculating r when data are ungrouped and grouped can be picked up from a standard textbook on statistical methods.

When Rho (the coefficient of correlation) is calculated, we can find out from tables the corresponding values of r. In order to test whether the coefficient of correlation obtained is a true correlation, we have to compute the standard error of r by the formula:

$$\sigma r = \frac{1 - r^2}{\sqrt{N - 1}}$$

The r must be at least 4 times the SE. We can be certain of a fair degree of relationship when the r is 6 times its SE. The coefficient will be a good indication of the relationship between the two traits or attributes only when the sample is random and reasonably large. Otherwise the coefficient obtained from another small sample may be different.

PART II

EXPERIMENTAL PROCEDURES

Individual Experiment Experiment 1

Experience and Behaviour

Problem

To study the experience and behaviour of an individual when he is stimulated. To understand the significance of the terms stimulus, response, experience and behaviour.

Material

A blunt pin.

Procedure

1. Give the following instructions: 'Be calm. I shall say "ready" and prick you with the pin. Describe your experience afterwards.'

2. Ask S to close his eyes. Say 'ready' and then prick him gently on the arm or neck.

3. Note down all the reactions you notice in him: change in facial expression, any withdrawal response, change in breathing, movement of limbs and other parts of the body, any exclamations, etc.

4. Ask S to note down in detail what happened in his mind before, during and after pricking. Ask him to note his feelings and emotions, his thoughts and his intentions and inhibitions.

5. Exchange places and repeat.

Results

1. Analyse the introspection and the notes of behaviour drawn by you and your subject.

2. Note the items mentioned in the introspective reports and the reports of behaviour by each member in the group. Classify and tabulate.

3. Define now each of the four terms: stimulus, response, experience and behaviour.

Experiment 1

Tables to record the items of behaviour and experience when S is pricked with a blunt pin

Individual

Serial Number	*Items of behaviour*	*Items of experience*
1		
2		
3		
4		
5		
6		

Group

Serial Number	*Items of behaviour*	*Frequency*	*Items of experience*	*Frequency*
1				
2				
3				
4				
5				
6				

TESTIMONY

Group Experiment — Experiment 2

Accuracy and Reliability of Report

Problem

To study the accuracy and reliability of observation and report.

Materials

A suitable picture mounted on a cardboard or plywood board with a flap to cover the picture; a stop watch.

Procedure

1. Give the following instruction to the subjects: 'You will be shown a picture for a short time. Observe it carefully as you will have to write a description afterwards.'

2. Expose the picture for 30 seconds and then ask them to write the description, giving as detailed an account as possible. Allow 10 minutes for writing the report.

Results

1. Calculate the number of words written.
2. Calculate the number of items mentioned.
3. Find the number of items correctly reported.
4. Find the coefficient of fidelity of report, thus:

$$\frac{\text{number of erroneous items}}{\text{total number of items in the picture}}$$

5. Find the coefficient of reliability of testimony:

$$\frac{\text{number of erroneous items}}{\text{total number of items reported}}$$

6. Find the mean, median and quartile deviation for the group for each of the above items.

7. Find the correlation between number of words written and number of items correctly reported by the rank difference method.

Experiment 2

Table to record the data regarding accuracy and reliability of report

Subject	*No. of words*	*No. of items*	*Items correct*	*Coefficient of fidelity*	*Coefficient of reliability*
A					
B					
C					
D					
E					
F					
Sum					
Mean					

TESTIMONY

Group Experiment — Experiment 3

Accuracy of Report and Suggestibility of the Subject

Problem

To study the accuracy of report and the suggestibility of the subject.

Materials

A key, a used stamp, a coin, a matchbox label, a monogram, all mounted on a cardboard or plywood board with a flap to cover; stop-watch.

A list of 25 questions (five questions on each article) including 10 suggestible questions (two on each).

N.B.: The questions should be so framed that they require only one-word answers.

Procedure

1. Give the following instruction to the subjects: 'You will be shown a number of articles for a short time. Observe them carefully as you will have to answer questions about them afterwards.'

2. The articles are exposed for 30 seconds to each subject, two at a time (if there are two sets four subjects can observe at a time). The subjects go back to their seats after observation and they do not speak to each other.

3. After all the subjects in the group have seen, they are asked to put down serial numbers in their book from 1–25 and answer the questions called out in an even tone by E.

4. The students exchange their books and check the answers as E calls out the correct answers.

Results

1. Find the number of correct answers for each subject.
2. Find the coefficient of fidelity of report.
3. Find the coefficient of reliability of testimony.

4. Find the coefficient of suggestibility, thus:

$$\frac{\text{number of suggestions accepted}}{\text{number of suggestive questions}}$$

5. Find the mean and the standard deviation for the above for the whole class.

6. Find the difference between means for correct answers for suggestible and non-suggestible questions, and the reliability of this difference by calculating the critical ratio.

7. Determine the rank order of articles according to the total number of correct responses for the group.

8. Determine the rank order of suggestible questions according to their suggestibility.

9. Determine the rank order of subjects in the group according to their suggestibility.

Table to record the group data collected

Individual	*No. of correct answers*	*Coefficient of fidelity*	*Coefficient of reliability*	*Coefficient of suggestibility*
A				
B				
C				
D				
E				

REFLEX ACTION

Individual Experiment — Experiment 4

Pupillary Reflex

Problem

To study the pupillary response to changes in intensity of light and the response to pain.

Materials

An electric light; switch; rheostat to vary the intensity of the light.

Procedure

1. Preliminary observation: make the subject sit facing the light. Cover one eye with opaque cardboard. Note the size of the pupil of the open eye. Suddenly uncover the other eye and note the change in the size of the pupil. Repeat this procedure five times and note if there is any exception.

2. Vary the intensity of light by using the rheostat and note the variation in constriction and dilatation for varying intensities.

3. Exchange places and repeat.

4. E pinches the skin of S's neck and notes any changes in the pupil. Repeat 5 times and note.

5. Exchange places and repeat.

Results

1. Is there any exception in the first series?

2. Note the relation, if any, between the variation in intensity of light and variation in the size of the pupil.

3. Take introspection in each series and note the relation between reflex behaviour and experience.

4. Is there any exception in the third series? Did you observe any variation in response from trial to trial? What is the effect of one reflex upon another?

Experiment 4

Table to record the data for the individual

Trial	*Intensity of stimulus*	*Response of the pupil*	*Pinch*	*Response*
1				
2				
3				
4				
5				

REFLEX ACTION

Individual Experiment — Experiment 5

Winking Reflex

Problem

To study the nature of reflex action and the ability of the individual to control the winking reflex.

Materials

Winking glass.

Procedure

1. Seat S in front of the glass with his chin on the chin rest so that the head is fixed. He should be almost touching the glass.

2. E then releases the hammer, letting it hit the glass directly in front of S's eyes. Repeat 20 times.

3. Observe the eyes and note whether the wink is a full wink (F), partial wink (P) or no wink (N).

4. After 2 or 3 minutes' rest ask S to close one eye and try to control the open eye. Give 20 trials and note as before.

5. Attach a sounder to the glass that will produce a noise when the hammer strikes and repeat the stimulation to both eyes 20 times, noting the reflex.

Results

1. Note the way in which the winking reflex occurs though there is no possibility of injury to the eye.

2. Giving values of 1 for full wink, 2 for partial wink and 3 for no wink, compute the scores for each individual in the class and calculate the average and standard deviation.

3. Find the difference between the 'ordinary' series and 'control' series and calculate the critical ratio.

4. What is the effect of noise upon the winking reflex? Compare the 'ordinary' series with the 'sounder' series.

Experiment 5

Table to note the results

With both eyes open		With one eye open		With both eyes open and the sounder	
Trial	*Response*	*Trial*	*Response*	*Trial*	*Response*
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Individual Experiment Experiment 6

Knee-jerk Reflex

Problem

To study the characteristic of the knee-jerk or patellar reflex and the factors which influence it.

Materials

Patellar tendon reflex apparatus.

Procedure

1. Select as subject some person having a marked knee-jerk.
2. Seat S in a relaxed manner with his leg swinging freely.
3. E will strike S's knee below the knee-cap with a hammer. The strength of the stimulus can be measured by the distance of the hammer drop as seen in the dial.
4. Fasten the shoe attachment so that the extent of the reaction may be read on the other dial by the movement of the attached lever.
5. Blindfold S and give him the following instructions: 'Relax and pay no attention to the movements around you. Try to keep your leg in the same position. If at any time the hammer does not strike the tendon, call out.'
6. When S indicates that the hammer did not strike the tendon, readjust, and take another reading. Discard the result noted earlier.
7. Give 10 trials, dropping the hammer from an angle of 45°. Adjust the position and release the bar in such a way that the hammer falls of its own weight.
8. Let an assistant record the number of units traversed by the indicator attached to the shoe.
9. Give a rest of 30 seconds between trials and after 10 trials allow a rest period of 2 minutes.
10. In the second series give the following instructions: 'When I say "ready", clasp your hands in front of your chest, and when I say "pull", pull with all your might, as though attempting to separate your hands.' Drop the hammer from the same position as before (45°) and take 10 readings. Give 2 minutes rest.

11. In the third series, with S in a relaxed state as in the first series, drop the hammer from 90° so as to increase the intensity of the stimulus. Take 10 readings, give 2 minutes rest and take another 10 readings. Obtain in all 20 readings in this series.

12. Now repeat the second series, 10 trials with tension and normal intensity of stimulus (45°).

13. Repeat the first series, 10 trials with relaxation and normal intensity of stimulus (45°).

14. Thus there will be data for 60 trials, as follows:

Stimulation	*Position of hammer*	*Number of trials*
Normal	... 45°	10
With Tension	... 45°	10
Intense	... 90°	20
With Tension	... 45°	10
Normal	... 45°	10

Results

1. Why is the A B C B A order followed?

2. What is the effect of tension on the extent of patellar reflex?

3. What is the effect of variation of intensity on the extent of the patellar reflex?

4. Study the reliability of difference regarding the effect of tension and intensity of stimulation.

5. Study the individual variations among the members of your group.

Table to record the data regarding knee-jerk reflex

Without tension			With tension		
Trial	*Position of hammer*	*Response*	*Trial*	*Position of hammer*	*Response*
1					
2					
3					
4					
5					

Individual Experiment Experiment 7

Chain Method

Problem

To study an individual's chain of thought and the factors determining the succession of ideas.

Materials

Each student will prepare a list of five stimulus words; stop-clock.

Procedure

1. Ask S to sit in a relaxed way and close his eyes.

2. Give the following instructions: 'When a word is called out speak aloud the words or ideas suggested by it. Give out the words as rapidly as they occur and do not stop to reflect on them or to criticize them. Continue till I say "stop".'

3. Note down all the words he speaks out in one minute. Then give the second stimulus word and note down the responses for one minute.

4. Exchange places and let your partner note down your responses to two stimulus words.

5. Exchange places and record the responses to the next three words in your list and give responses later to the next three words in your partner's list.

Results

1. Calculate the mean association time for the results of the last three stimulus words. The first two sets of responses are treated as practice trials.

2. Study the relations between the several responses and classify the associations.

3. Calculate the average and quartile deviation for the group as a whole.

4. Note the frequencies for each class of associations for the group.

5. Analyse with the help of S the 'individual' associations.

6. Analyse the responses according to the primary and secondary laws of association.

Classification of Associations

1. Contiguity in space or time: door—lock; lightning—thunder.

2. Similarity or contrast: adventure—enterprise; day—night.

3. Causality: joke—laughter; prick—pain.

4. Co-ordinate, subordinate or superordinate: table—chair; animal—dog; fruit—food.

5. Whole—part or part—whole: table—leg; page—book.

6. Verb—object or object—verb: eat—food; fruit—cut.

7. Substance—attribute or attribute—substance: sugar—sweet; sharp—knife.

8. Rhyme: well—bell.

9. Word-compounding: well—well known.

Laws of Association

Primary: 1. Law of contiguity (space and time).
2. Law of similarity (similarity or contrast).
3. Law of systematic relations.

Secondary: 1. Primacy; 2. Recency; 3. Frequency and 4. Vividness.

Table to record data

Stimulus word	*Response word*	*Time*	*Classification of association*	*Individual association*
1				
2				
3				
4				
5				

ASSOCIATION

Individual Experiment Experiment 8

Word list method

Problem

To study the nature of word reactions and the time taken to respond.

Materials

20 words selected from Kent-Rosanoff list; Kent-Rosanoff list of responses with frequencies; stop-watch.

Procedure

1. Give the following instruction to S: 'Say the very first word that occurs to you immediately upon hearing the stimulus word.'

2. Note down the time and the response and any other behaviour peculiarities.

3. Repeat the stimulus words and ask him to give the same response as he gave formerly for each stimulus word; note down the time and the response.

4. Note introspection of the subject for some of the peculiar responses.

Results

1. Compute the mean response time and the SD.

2. Note the number of words requiring more than M + 1. SD time (one standard deviation more than the mean time).

3. Note the number of words giving responses with low or zero frequency according to Kent-Rosanoff list.

4. What are the words for which there is a failure to respond or an incorrect reproduction?

5. From these 'complex indicators' and on the basis of the introspections find out problems worrying him.

6. Arrange the members of the group according to the mean response time and according to the complex indicators.

Experiment 8

Table to record data

Stimulus word	*Response word*	*Time*	*Reproduction word*	*Time*
1				
2				
3				
4				
5				

ASSOCIATION

Individual Experiment — Experiment 9

Strength of motives

Problem

To measure the strength of motives according to the association technique.

Materials

Each student prepares four lists of ten words in each of the following categories: neutral, food and drink, fear, sex; a stimulus list incorporating these words in a haphazard order; stop-watch.

Procedure

Give instructions as in the last experiment and follow the same procedure, noting the response time and response word and the reproduction time and word.

Results

1. Calculate the mean and SD for each of the four lists.
2. Compare each of the three sets of responses with the neutral series.
3. Note the failures to respond and reproduce and the words taking more than M + 2. SD (neutral) in each of the three lists.
4. For each S find the order for the three sets of motives.
5. Put together the results of the group.

Experiment 9

Table to record group data

Individual	Neutral series			
	Mean time	*No. of words M + 2. SD*	*Failure to respond*	*Failure to reproduce*
A				
B				
C				
D				
E				

(Note similarly for the Food and Drink, Fear and Sex series.)

Demonstration Experiment Experiment 10

Crime detection

Problem

To detect the 'guilt complex' by means of the free association test.

Materials

Ten objects with emotion-stimulating value are selected and put in two boxes which are kept in two different rooms in the laboratory; stop-watch.

Procedure

1. Select two volunteers and give them the following instructions: 'In room No.....and room No.....two boxes are kept. After leaving the classroom decide between yourselves which of you will go to which room. Enter the room and examine the articles carefully. Write a description of the articles and put the paper in your pocket. Wait in the room till you are called for.'

2. When SS have left the classroom E describes the articles in each box. The group now prepares a stimulus word list with two words for each object. The words referring to Box A are designated 'A' and those referring to the other box 'B'. The words are mixed up in a haphazard order and each student notes down the final list with the key letters A and B.

3. One of the subjects is recalled and given the following instructions: 'You will now hear a list of words some of which are related to the box opened by you. Give the first word that comes to your mind when you hear the stimulus word, Be quick, as delay will mean detection. On the basis of your responses an attempt will be made to find which box you opened.'

4. Give five trial words and then proceed to the list. The students will note the response words and E the time. Give the list once again and ask S to reproduce the response.

5. Repeat the same procedure recalling the other S and note down the response word and time and the reproduced word and time.

6. Each student will now analyse the data by himself and find which S has seen which box.

Results

1. Find the mean reaction time for each S.

2. Calculate the mean reaction time for Box A words and Box B words for each S and find the difference.

3. Find the significant responses for A list and B list for each S.

4. Find the failures to respond for each list for each S.

5. Similarly find the number of times the stimulus words are repeated.

6. What are the words for which there is failure to reproduce?

7. On the basis of these data find which box has been opened by which S.

8. Find the ratio of critical/non-critical mean reaction times.

9. Verify.

10. Which of the diagnostic signs were more useful? Can you explain why some criteria of guilt were more successful than others?

Table to record data for each individual

Stimulus word	*Response word*	*Time*	*Reproduction word*	*Time*
1				
2				
3				
4				
5				

Group data

Data			*Individual X*	*Individual Y*
Mean Response Time	...	A series		
		B series		
Significant Response	...	A series		
		B series		
Failure to Respond	...	A series		
		B series		
Repetition of Stimulus	...	A series		
		B series		

ATTENTION

Individual Experiment Experiment 11

Concentration

Problem

To discover the number of times attention wanders and to find out conditions which help concentration of attention.

Materials

Pen or pencil; stop-clock.

Procedure

1. Give the following instructions to S: 'Look at your pencil. Concentrate your attention upon it for one minute. When your attention wanders from the object indicate it by a movement of your left hand.'

2. E notes down the number of times attention wanders during the one-minute period.

3. In the second series give the following instructions: 'Look at the pencil. Think about its size, colour, material with which it is made, flaws in the making, its uses, etc. Indicate as before when your attention wanders.'

4. E notes down the number of times attention wanders during this one-minute period.

5. Ask S to write an introspective account of his experience in the first and second one-minute periods.

Results

1. Find the number of times attention wanders in the first series and in the second series. Note the difference.

2. Account for this difference, taking also into account the introspective report of S.

3. Collect the data for the class. Find the mean and SD for the two series and calculate the reliability of the difference.

4. State the law of attention based on this work.

Experiment 11

Table to record group data

Individual	No. of times attention wanders	
	Series 1	*Series 2*
A		
B		
C		
D		
E		
Mean		
SD		

ATTENTION

Individual Experiment — Experiment 12

Distraction

Problem

To study the way in which distraction affects the task on hand.

Materials

Letter cancellation sheets; stop-clock.

Procedure

1. Give practice to S in cancelling every *a*, *e* and *o* as fast as he can.

2. Let S cancel the letters for one minute.

3. Again S will cancel the same letters for one minute. During this minute E introduces distraction by tapping loudly on the table every five seconds.

4. Cancellation for one minute.

5. Cancellation with distraction—pinching once in 5 seconds.

(Various kinds of pleasant as well as unpleasant modes of distraction may be used. Also the task may be made more difficult.)

Results

1. In scoring, count the number of letters correctly marked in one minute and subtract 2 for every one missed or incorrectly marked.

2. Find the effect of distraction by finding the difference between the scores with and without distraction.

3. Find the effect of variation in the nature of distraction on the basis of the scores in the different series.

4. Find the mean and the SD for the group and study the individual differences.

Experiment 12

Table to record group data

Individual	Score	
	Without distraction	*With distraction*
A		
B		
C		
D		
E		
Mean		
SD		

ATTENTION

Group Experiment — Experiment 13

Fluctuation

Problem

To measure fluctuation of attention; to study the effect of voluntary control of fluctuation.

Materials

A figure in reversible perspective; stop-clock.

Procedure

1. Ask the whole group to look at the figure and note down the changes which occur.

2. S will look at the figure for one minute, allowing the eyes to roam at will over the figure. When there is a reversal he records it by a stroke. Total the number of reversals for one minute. Record for three trials. Give a rest of half a minute between successive trials.

3. Proceed as before except that S is instructed to make as *many* reversals as possible. Three one-minute trials are made.

4. In the third series S tries to *hold* the figure in one position, recording the number of reversals which occur in spite of his effort. Three one-minute trials are made.

Results

1. Compare the total number of reversals under the three conditions.

2. Find the mean and SD for each condition for the whole group.

3. Are the differences reliable?

Experiment 13

Table to record group data

Individual	Number of Fluctuations		
	Normal	*'Many' series*	*'Few' series*
A			
B			
C			
D			
E			
Mean			
SD			

Individual Experiment Experiment 14

Span

Problem

To determine the span of attention to visual stimuli.

Materials

A tachistoscope providing an exposure time of 1/10th of a second; fifteen cards showing dots in random arrangement and varying in number from four to eight per card—3 cards at each step.

Procedure

1. Seat S so that he can have a clear view of the aperture. Give a few preliminary trials so that he can observe the background on which the dots appear.

2. Give the following instructions: 'You will be shown a series of cards with dots. Give out the number of dots you see. Observe carefully.'

3. Shuffle the 15 cards with dots so that they are presented in a random order. Note down the response for each card. Note the trial number, stimulus, response.

4. Shuffle them again and present them. Record the data as before so that there are 30 trials altogether and each card is presented six times.

Results

1. Check the accuracy of each response and find how many cards are correctly estimated at each step: four dots, five dots, etc.

2. S's span is the largest number of dots correctly estimated in five out of the six trials.

3. Obtain the class data and calculate the average span and study the individual differences.

Supplementary Experiment

1. Instead of single dots write pairs of dots and find the span. After this groups of three, four or five dots may be used.

2. Observe whether the span of attention increases when more dots are being responded to.

Experiment 14

Table to record data regarding span of attention

Trial	*No. of dots estimated*	*Actual No. of dots*
1		
2		
3		
4		

Individual Experiment Experiment 15

Division

Problem

1. To study the method by which two disparate physical activities are carried out.

2. To study the ability to carry out two disparate mental activities.

3. To study the ability to carry out two disparate acts, one physical and one mental.

Materials

Division of attention board with a circular and a triangular groove; two metal-edged styluses; two impulse counters; blank writing paper; stop-watch.

Procedure

SERIES A: 1. Connect the terminals of the board with the counters, battery and styluses in two circuits so that the number of movements in the two grooves can be recorded.

2. Ask S to trace the circular pattern with right hand, as fast as possible, for one minute. Record by means of the impulse counter the number of times he can trace it.

3. Let him trace the triangular pattern with his left hand, as fast as possible, for one minute. Record.

4. Let him trace both the patterns, using the same hands as before, simultaneously as fast as possible for one minute. Record.

If impulse counters are not available S may be asked to put dashes with his right hand for one minute and then dots with his left hand for one minute, and finally do both the activities for one minute.

SERIES B: 1. Ask S to recite in undertones, as fast as possible, the alternate letters of the alphabet, A, C, E, etc., for one minute. When he reaches Z he is to begin again and continue till the time limit. E should keep count of the number of letters by making pencil strokes.

2. Let him write down, as fast as possible, every third number, beginning with 1, 4, 7, etc. When he reaches 100 he is to begin again with 1 and continue till he is stopped at the end of one minute. Record.

3. He must now do both the operations simultaneously for one minute, E noting the letters as before.

SERIES C: 1. Ask S to trace the triangle for one minute.

2. Let him recite the alternate letters for one minute.

3. Let him do both the operations simultaneously for one minute.

Results

1. Compute the coefficient of division by the formula $1 - \frac{D_1 + D_2}{S_1 + S_2}$, where S_1 and S_2 stand for the output in the two single tasks and D_1 and D_2 for the same tasks performed simultaneously (double task).

2. Compare the coefficient of Series A with Series B and with Series C and of Series B with Series C.

3. Account for the differences in the three series.

4. Put together the class results.

Table to record individual data

Series	*Single task*		*Double task*		*Coefficient of division*
	1	2	1	2	
A					
B					
C					

Group data

Individual	Coefficient of Division		
	Series A	*Series B*	*Series C*
A			
B			
C			
D			
E			
Median			

ATTENTION

Individual Experiment — Experiment 16

Attitude or Set

Problem

To study the effect of directing the attention in a specific manner.

Materials

Two series of anagrams, ten in each series, each anagram to be composed of five letters. The first series consists of anagrams referring to objects in general like D U C L O (cloud), E C I M R (crime). The second series consists of anagrams referring to household goods like E L T A B (table), A I R H C (chair). A piece of paper with aperture sufficient to reveal one anagram at a time; stop-watch.

Procedure

1. Arrange the anagrams of the first series in a column, cover them and give the following instructions: 'You will see a series of anagrams, one at a time. The words are general words. You must look at the letters, find the word and call out.'

2. As the anagram is exposed start the stop-watch. When S calls out the word, stop the watch. Record response and time. Expose the next anagram and start the stop-watch simultaneously.

3. Allow a time limit of 30 seconds for each anagram and record a 'failure' at the end if S is unable to respond.

4. In the second part of the experiment give the following instructions: 'The anagrams in this series refer to household articles. Direct your attention to the household articles and discover the word.'

5. Expose the anagrams in the second series one by one and record time and response as before.

Results

1. Find the median times for the two series and compare them.

2. Usually the times for the indefinite set are about 2.5 times longer than for the definite set. Compare this proposition with your results.

3. Collect the data for the whole group and find out the proportion for the group.

Table to collect group data

Individual	Indefinite set		Definite set	
	Median time	*No. of failures*	*Median time*	*No. of failures*
A				
B				
C				
D				
E				
Median				

Individual Experiment Experiment 17

Colour preference

Problem

1. To determine the order of preference for the colours presented.

2. To study the difference between the rank order method and paired comparison method.

3. To determine the effect of background upon colour preference.

Materials

Six pieces of coloured paper, one inch square (red, yellow, green, blue, purple and orange), or a colour wheel; larger sheets (7″ × 10″) of the same colours mounted on cardboard; a grey sheet.

Procedure

1. Place all the colours upon the grey background and ask S to arrange them in the order of preference. Let him place the colour that he likes best on the extreme left and the colour that he likes the least on the extreme right and arrange the other colours in between. He is permitted to make any number of shifts till he is satisfied that the order best represents his preference.

2. Present each colour with one other colour on the grey background and note the colour preferred by S in the appropriate cell in a correlation record sheet. Present every colour with every other colour. Present each pair twice, first with one colour to the left and next with the other colour to the left. Determine the total preferences for each colour and find the final ranking.

3. With each colour as the background, find by the paired comparison method the rank order for the various colours.

Results

1. Compare the rank order according to the ranking method with the rank order according to the paired comparison method.

2. Compute the coefficient of correlation by the rank difference method.

3. What is the relationship between the colour of the background and the rank order for colours?

4. Which is the colour liked best by the group as a whole and which is the least liked? Note the relationship between the preference order for the group as a whole and the preference order for the various individuals. How many conform and how many deviate from the group preference order?

5. What is the colour combination most liked by yourself and by the group as a whole? What is the combination least liked?

Table to record data regarding colour preference

Colours	Red	Green	Blue	Yellow	Orange	Purple	*Total preferences*	*Final ranking*
Red								
Green								
Blue								
Yellow								
Orange								
Purple								
Total preferences								

Group Experiment Experiment 18

Facial expression of emotions (photographs)

Problem

To study the accuracy with which emotions are judged by observing facial expressions.

Materials

A set of facial expression cards with numbers on back. List of emotions depicted.

Procedure

1. Study the photographs one after the other and assign to each the name which you consider best identifies the emotion depicted.

2. As a second test, write in the first column of a table the names of emotions in the order in which they are given you by E. Look at the series of pictures. Find the picture which you consider represents the first emotion. Place the number in the second column opposite the name. In the same way write down the number of the picture for each emotion.

3. Take introspection regarding the cues used for identification after each test.

4. E gives the emotion intended for each picture and the correct responses in the two lists are checked.

Results

1. Compare the number of correct responses in the two tests. Which list is better? Why?

2. Collect the results of the group as a whole and compare with the correct responses given by E.

3. Which emotional expressions are judged more accurately and which less? Why?

4. On the basis of the analysis of the introspective reports determine the nature of the cues used in forming judgements.

Experiment 18

Table to record group data

Individual	No. of correct responses	
	Without names	*With names*
A		
B		
C		
D		
E		
Sum		
Mean		

Group Experiment Experiment 19

Facial expression of emotions (model)

Problem

To study the relative importance of the different parts of the face for emotional expression.

Materials

Large facial profile with changeable brows, eyes, nose and mouth.

Procedure

1. The profile is set up in full view of the group. Various combinations of features to represent various facial reaction patterns are tried.

2. After each combination a short time is allowed for the subjects to give it a name and E notes the numbers of the particular parts used in obtaining the facial pattern. Responses are entered in tabular form.

Results

1. For each pattern find the variation in judgment among the members of the group.

2. Take the model response of the group for each pattern and find the deviation of each S from this.

3. Which are the emotions in which there is very little deviation and which are the emotions in which there is considerable deviation? Why?

4. Analyse the relation between the various parts of the face and the particular emotional pattern. Study in particular the pattern of brow and mouth.

5. Compare the class results with the suggestions given by Piderit regarding these patterns. Find the subjects who agree very closely with the standard.

Experiment 19

Table to record the data

Pattern	Number of the part used				*Group Judgement*
	Brow	*Eye*	*Nose*	*Mouth*	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Demonstration Experiment Experiment 20

Bodily changes in emotion (pneumograph)

Problem

To study the variations in breathing under conditions of (i) concentrated attention and (ii) agreeable and disagreeable sensations.

Materials

Pneumograph, recording tambour, kymograph, time marker.

Procedure

1. Fix the pneumograph round the subject's chest or abdomen after watching his breathing.

2. Place the time marker and the recording tambour on the smoked paper of the kymograph.

3. Seat S with his back to the kymograph. Blindfold him and obtain the normal breathing curve.

4. Give a two-digit by two-digit problem for multiplication and ask him to solve it mentally. Place a cross on the drum indicating the point at which the problem was given and the point at which the answer was given.

5. Without warning produce a disagreeable sound. Note the positions on the drum at which the sound began and ended.

6. Suddenly present a scent bottle near his nose. Note the positions on the drum at which the odour began and ceased.

7. Remove the paper from the drum, note the name of S, stimuli used, etc., run the paper through a thin solution of lacquer or shellac and hang it up to dry.

8. During the course of the experiment take the introspective report of S.

Results

1. Compare the rate and amplitude of normal breathing with (i) the curve for work under concentrated attention; (ii) the curve for disagreeable sound and (iii) the curve for pleasant odour.

2. Is it possible to judge the nature of the feeling solely on the basis of the physiological concomitant?

3. Of what value are the introspective reports for differentiating the subject's affective responses?

Table to record individual data

Series	*Rate*	*Amplitude*
Normal breathing		
Concentrated attention		
Disagreeable sound		
Pleasant odour		

Group data

Individual	Normal		Attention		Unpleasant		Pleasant	
	Rate	*Amplitude*	*Rate*	*Amplitude*	*Rate*	*Amplitude*	*Rate*	*Amplitude*
A								
B								
C								
D								
E								

REACTION TIME

Individual Experiment Experiment 21

Simple reaction time

Problem

To determine the time taken by an individual to respond to a visual stimulus.

Materials

Different kinds of apparatus are available for measuring time. The most accurate are Hipp's chronoscope and Bergstrom's pendulum chronoscope. An electric chronoscope, or a kymograph with time marker may also be used; or, finally, the simple Vernier's chronoscope.

To acquaint the student with the problems and procedure the simple Vernier's chronoscope is very useful. It consists of two pendulums and two keys with caps. The longer pendulum is adjusted to make 75 complete swings in one minute, and the shorter 77 swings. The wires attached to the pendulum bobs are slipped under the metal caps of the two keys—the longer pendulum to E's key and the shorter to S's key.

The wiring should be so arranged that when E presses his key the longer pendulum is released and an electric lamp goes on. When S presses his key the shorter pendulum is released and the lamp is put off. E starts counting the swings of the longer pendulum till the two pendulums come to swing in unison. The number of swings counted before unison occurs gives the reaction in fiftieths of a second. When this is multiplied by 20 we get the duration in thousands of a second, or *sigma*.

Procedure

1. Take a few preliminary trials to acquaint S with what he has to do. Give him the following instruction: 'When you observe the light, press this key so that the light is put off.'

2. Say 'ready', and after an interval of one to two seconds press your key.

3. After S presses his key count the swings of the long pendulum till the two pendulums come to swing in unison. Record and multiply by 20. As the longer pendulum makes 75

complete swings in one minute each swing takes 0.8 seconds, and the shorter pendulum takes 0.7792 seconds. The difference between the two, 0.0208 seconds, is considered to be roughly one fiftieth of a second. So when this is multiplied by 20 the result is in thousands of a second, or *sigma*.

Table to record individual data

Trial	*Difference*	*Sigma value*
1		
2		
3		
4		
5		
6		
—		
—		
20		
Sum		
Mean		

Group data

Individual	*Mean Sigma value*
A	
B	
C	
D	
E	
Sum	
Mean	

Demonstration Experiment Experiment 22

Complex Reactions

Problem

To study, by the reaction time method, the influence of different degrees of complexity of behaviour on the reaction time.

Materials

Chronoscope with connexions. Red and green lights.

Procedure

Series A: The Influence of Attitude or Set

1. Take 20 readings as in Experiment 21 after instructing S to concentrate his attention on the stimulus. This will give the sensorial reaction time.

2. Take another 20 readings with instruction to concentrate attention on the rapidity of response. This will give the muscular reaction time.

Series B: Discrimination Reaction

1. Arrange in such a way that either a green or red light goes on when E's key is pressed.

2. S is instructed to react only to one colour. (Instead of two, E may arrange three, four or five different stimuli and present the stimuli in a haphazard order, asking S to react only to one particular stimulus.) Take 20 readings.

Series C: Choice Reaction

1. E presses either the key that exposes the red light or the key that exposes the green light. Give 20 trials. Out of the twenty trials ten are red and the other ten green. E arranges the stimuli in a chance order so that S cannot anticipate the nature of the stimulus from his preceding experience. E presents the stimuli according to a prearranged order.

2. S has two keys. He is instructed to press the right key for the green light and the left key for the red light. (He may be instructed to use only one hand, or the right hand for the right key and the left hand for the left key. Specify whichever procedure is followed. Stick to it.)

Series D: Association Reaction

1. Prepare a list of 20 words for controlled association. Press the key and say the word simultaneously. Ask S to react with the controlled response, pressing his key at the same time.

2. Prepare a list of 20 words for free association. Following the same procedure, obtain the response words and the response time for each stimulus.

Results

1. Calculate the mean and SD for each of the six sets of trials.

2. Study the differences in the central tendency and the measure of variability among these figures. Compare with the figures for simple reaction.

3. Construct a 'bar diagram' for all these seven kinds of situations.

4. Collect the data for the class and study the differences.

5. Take introspective records for each of these seven situations and study the influence of the instruction and the nature of the task on experience.

Table to Record individual data

Condition	*Mean value*	*SD*
Simple Reaction		
Sensory Attitude		
Muscular Attitude		
Discrimination		
Choice		
Controlled Association		
Free Association		

Individual Experiment Experiment 23

Progressive weights

Problem

To determine individual differences with respect to suggestibility using the progressive weights.

Materials

One set of 10 progressive weights.

Procedure

1. Place the weights in the order given by the number at the bottom.

2. Ask S to lift the first weight and then the second, third and so on, lifting each weight only once. He will give his judgement whether the second weight is heavier than the first. Next he lifts the third and gives his judgement in relation to the second and so on, till he comes to the last. So he will give seven judgements in all which should be noted by E in the appropriate places.

3. E and S exchange places and the experiment is repeated.

Results

1. Now weigh the several blocks and note the weights against each.

2. Compare the judgements with the actual weights and determine to what extent each individual is suggestible, in terms of the number of times he accepts the suggestion based on previous experience.

3. Collect the data for the class and determine mean and SD, and arrange the individuals in the group according to their suggestibility.

Alternative Procedure

1. Place the weights in a jumbled way and ask S to arrange them in order of heaviness, starting from the lightest.

2. Note the actual weight of each and determine the influence of suggestion from the progression, by studying the serial order.

Experiment 23

Table to record group data

Individual	*No. of times suggestion accepted*
A	
B	
C	
D	
E	
Sum	
Mean	

Demonstration Experiment Experiment 24

Illusion of warmth

Problem

To test the suggestibility of S by using the warmth tester apparatus.

Materials

Box with two lamps, lamp switch, secret switch, resistance wire on rubber core; stop-watch.

The lamps are wired in the same circuit as the resistance coil. As the lights burn the coil begins to heat. Concealed is a secret switch that serves to disconnect the coil and the lamp circuit so that the lamps burn but the coil will be cool.

Procedure

1. In the trial series ask S to place his thumb and fingers on the coil. Put the lights on and ask him to report when he feels warmth. Start the stop-watch when you put on the switch and stop it when he reports warmth.

2. Now give the following instructions: 'This is a test to find your ability to feel small amounts of warmth. After I put the lights on, as soon as you feel the warmth, say "now" and remove your fingers. The more sensitive you are the quicker you will feel it.' (These instructions may be given to a subject who knows nothing about the nature of the experiment.)

3. Give 20 trials of which 10 will have no warmth whatever. Arrange stimuli in a haphazard manner.

4. After every trial allow 2 minutes for the resistance wire to cool.

5. In the suggestion trials if S does not feel warmth in a few seconds open the secret switch so that he feels the warmth. These trials are not taken into account when the results are worked.

Results

1. Note the number of times the suggestion of warmth is accepted.

2. Find the mean reaction time for the warmth trials and that for the suggestion trials.

3. Is this difference reliable?

4. Collect data for the class and arrange the students in the order of suggestibility.

SUGGESTION

Group Experiment — Experiment 25

Suggestible questions

Conduct Experiment 3 once again and arrange the students in the class according to their suggestibility.

Now find the coefficient of correlation by the rank difference method between the results of Experiment 25 and Experiment 26; Experiment 25 and Experiment 27; and Experiment 26 and Experiment 27.

Are these coefficients reliable?

What do they tell us about a factor of suggestibility?

PERCEPTION

Demonstration Experiment — Experiment 26

Selection and grouping

Problem

To study the changes in perception due to the factors of selection and grouping.

Materials

Dot Figure A—13 dots (small circles) arranged as a square on white background in five rows of 3, 2, 3, 2 and 3. Dot Figure B—28 dots (white circles) arranged as a triangle on black background in seven rows of 1, 2, 3 . . . 7. (See Appendix B.)

Procedure

1. Look at Dot Figure A.
   (i) What does it look like?
   (ii) Observe the shifts in the grouping of dots.
   (iii) Does the shifting take place suddenly or gradually?
   (iv) Try to describe the various patterns.
   (v) Do you see more than one pattern at the same time?
   (iv) Do two patterns exist simultaneously or are they mutually exclusive? Observe and record.

2. Look at Dot Figure B. Make the above observation on this figure also.

Results

Formulate the laws of figure and ground, and the principles of selection and grouping, on the basis of your experience with the above figures.

Show how structured figures arise out of unstructured material.

Note that though the dots do not change the patterns change.

Are the stimuli constant or do they vary?

Analyse the role of the stimuli, and the relations between stimuli and the observer, in perception.

Do we perceive what is presented or do we react to the stimuli and the relations between stimuli?

Supplementary

Observe the changes in figure and ground in the following ambiguous figures:

(a) Octagon with four black triangles and four white triangles.
Is it a white cross on a black background or a black cross on a white background?

(b) 12 black squares, arranged symmetrically in four rows with interstices in white.
Are they white bars on a black background or black squares on a white background?

Group Experiment Experiment 27

Reversible perspectives

Problem

To study the changes in perception due to changes in perspective.

Materials

Vase-face figure, Scripture's 'Blocks' figure and a figure with a six-pointed star in a hexagon. (See Appendix B.)

Procedure

1. Look at the vase-face figure and note the way in which the vase pattern and the two-face pattern alternate. For how long can you look at the vase figure alone?

2. Look at the reversible cube figure. How many figures do you see? Describe each.

3. Look at the star figure. How many two-dimensional figures do you perceive? Describe each. How many three-dimensional figures do you perceive? Describe each.

Results

Review the results of Experiment 28 in the light of your experience with the reversible perspectives.

Do we see what is given?

Group Experiment Experiment 28

Measurement of optical illusions

Problem

To measure the Muller-Lyer illusion and the horizontal-vertical illusion.

Materials

Muller-Lyer figure with the feather line variable in length; horizontal-vertical figure with the vertical line variable in length; metre rod.

Procedure

1. Use the ascending method and find out at what point the variable line in the Muller-Lyer figure appears equal to the standard. Measure and record.

2. Use the descending method and find the length of the variable line which appears to be equal to the standard. Measure and record.

3. Similarly measure and record the length of the vertical line which appears to be equal to the horizontal line by the ascending and descending methods.

Results

1. Compute the mean error for each S for each of the two figures.

2. Compute the mean error for the group as a whole for each of the two figures.

3. Study the individual variations.

4. Study the difference in the mean errors for the ascending and descending methods and account for the difference, if any.

PERCEPTION

Individual Experiment — Experiment 29

The span of apprehension

Problem

To determine the effect of meaning upon perception and to determine the span of apprehension.

Materials

Tachistoscope providing an exposure time of 1/10th of a second; fifteen cards with from 3 to 7 letters, three cards at each step (the letters forming nonsense combinations); twenty-four cards with from 3 to 10 letters, three cards at each step (the letters forming words).

Procedure

1. Seat S so that he can have a clear view of the aperture. Give a few preliminary trials.

2. Shuffle the 15 cards with nonsense combinations of letters and present them in a random order. Shuffle them again and take another set of readings. This will give a total of 30 trials.

3. Shuffle the 24 cards with meaningful combinations and present them in a random order. Shuffle them again and take a further set of readings. This will give a total of 48 trials.

Results

1. Check the accuracy of response. Find out how many cards were correctly responded to at each step. S's span is the largest number of letters correctly estimated in five out of six trials.

2. Compare the span for the two series and account for the difference.

3. Collect the data for the whole class and find the mean span for the two series.

Supplementary Experiment

Materials

1. Prepare three sets of cards with six cards in each set.

2. Each card should contain ten letters, arranged in three groups.

3. One set of six cards will contain three nonsense combinations.

4. The second set will contain three disconnected words.

5. The third set will contain three words forming a sentence.

Procedure

1. Present the cards in the following order:

3 cards of nonsense combinations,
3 cards of sentences,
6 cards of words,
3 cards of sentences,
3 cards of nonsense combinations.

2. Give the following instructions: 'You will see for a brief period cards containing a number of letters. The letters may be connected to form words and sentences or may be merely disconnected. Watch closely and write what you see each time.'

Results

1. Find the average number of letters correctly reproduced for each type of material.

2. Explain why related materials are more easily apprehended.

3. Collect the class data and calculate the mean span for each type of material.

4. Compare the results with the earlier procedure.

5. Compare the results for span of apprehension with results for span of attention.

PERCEPTION

Demonstration Experiment — Experiment 30

Perception of movement

Problem

To study the phi-phenomenon.

Materials

Phi-phenomenon box with two lights so wired with a mercury metronome that the lights will burn alternately; metre rod; stop-watch.

Procedure

1. Set the metronome at 60. Let S stand three metres away from the box. Start the metronome and ask S to report what he sees. Note the response time.

2. Take ten readings.

3. Take ten readings with the metronome at each of the following speeds: 30, 45, 75, 90 from the same distance.

4. Take ten readings with S at each of the following distances from the box: 1 metre, 2 metres, 4 metres and 5 metres, with the metronome at 60.

5. Record his introspections after each set of readings.

Results

1. On the basis of the several readings determine the optimum speed and distance at which the phi-phenomenon occurs.

2. What is the effect of variation of distance upon the perception of apparent movement?

3. What is the effect of variation in the interval between visual stimuli upon the perception of apparent movement?

4. Collect the group data and study individual variations.

Demonstration Experiment Experiment 31

Laws of colour mixture

Problem 1

To find the proportions of red and green and of blue and yellow required to produce a grey and to match this grey with a mixture of black and white.

Materials

Motor or hand colour mixer; large colour discs of red, green, blue and yellow, small discs of white and black; graduated discs, large and small; screen of neutral grey for background.

Procedure

1. Take equal proportions of red and green, making sure that the overlapping edge is away from the direction of rotation.

2. Rotate the colour wheel and after flicker is abolished ask S to look at the disc and report whether it is colourless. If there is any colour ascertain whether it is reddish or greenish and reduce the proportion of that colour. If necessary a third colour may be added. When S reports that he is perceiving grey, measure the sectors and record.

3. Superpose on the large colour discs the small white and black discs in equal proportions. Ask S to compare the two greys. Alter the proportions till the two greys match. Measure the sectors and record.

4. Repeat the procedure with blue and yellow discs.

Results

1. Collect the class data to find the variation in proportions of the colours to produce grey.

2. State the first law of colour mixture.

Problem 2

To study the nature of colour experience when non-complementary colours are mixed.

Materials

Colour wheel; large discs of red, green, yellow and blue.

Procedure

1. Mix equal proportions of red and yellow.
2. Mix equal proportions of yellow and green.
3. Mix equal proportions of red and blue.

Results

1. Note the nature of colour produced by the different combinations.
2. See the difference between the mixture of complementary and non-complementary colours.
3. State the second law of colour mixture.

Problem 3

To study the nature of the experience when all the four fundamental colours are mixed.

Materials

Same as for Problem 1.

Procedure

1. Start with equal proportions of all the four colours.
2. Vary proportions, if necessary, till S perceives grey.
3. Take black and white discs and find the proportion of these two which will match the grey in the large disc.

Results

State the third law of colour mixture.

SENSORY AND MOTOR PROCESSES

Demonstration Experiment — Experiment 32

Some phenomena of audition

Problem

To demonstrate some of the phenomena of audition.

Materials

Tuning forks, resonance boxes, monocord or sonometer; stopwatch.

Procedure

1. Show the difference in pitch by striking different tuning forks.

2. Show the difference in intensity by striking one tuning fork harder or softer.

3. Demonstrate the phenomenon of resonance.

4. Take a tuning fork of 256 vibrations per second and others varying by 2, 4, 8 and 10 vibrations and demonstrate the phenomenon of beats. Ask S to count the beats and note the time by the stop-watch.

5. Using the sonometer, help S to analyse the overtones.

Results

Note down the experiences under the different conditions.

SENSORY AND MOTOR PROCESSES

Individual Experiment Experiment 33

Cutaneous sensibility

Problem

To study some phenomena of cutaneous sensibility.

Materials

Brass rods, rubber stamp and ink, ice, cold water, hot water, hair mounted on a rod, bristle or pin mounted on a rod.

Procedure

(a) *Cold spots*

1. The area on the back of S's hand to be explored is marked with a rubber stamp. Impression is also taken on notebook.

2. Immerse brass rods in ice-cold water. Take one, dry it and move the point along the line, keeping the rod vertical. S is instructed to call out when he experiences a cold sensation. Mark the spot on the note book. Change rods frequently and explore line after line and note the cold spots.

(b) *Heat spots*

1. Immerse the brass rods in water heated to about 45° to 50°C.

2. Proceed as above and note the spots, using a different mark or different coloured ink.

(c) *Touch spots*

1. Mark with rubber stamp the same area on the other hand and take the impression on notebook.

2. By means of a magnifying glass detect the hairs on the surface and mark these points on the map in notebook. Cut off the hair.

3. Stimulate with a hair mounted on a rod and at right angles to it. Keep the hair perpendicular to the surface of the skin.

4. Explore the area by a series of regular touches, each being one mm. apart from the next.

5. When S reports that he feels the touch sensation, mark the point on the notebook.

(d) *Pain spots*

1. Use the rod with a needle or bristle; see that the needle does not pierce the skin.

2. Adopting the same procedure as in (c), mark the spots giving rise to the pain sensation.

Results

1. Put the results of the whole work on one large sheet of paper marking the hair endings, cold spots, heat spots, touch spots and pain spots.

2. Analyse the introspective data for each experience.

(e) *After-image of touch*

1. Tap the blunt head of a needle upon the back of your hand.

2. Note what happens after a short pause and describe the experience.

(f) *Temperature adaptation*

1. Take three vessels. In one put very cold water, in the second tepid water and in the third hot water.

2. Place one hand in the very cold water and the other in the hot water for a few minutes.

3. Now place both hands in the second vessel with lukewarm water.

4. Note the temperature sensations of the two hands.

Group Experiment Experiment 34

Imagery: (a) Vividness

Problem

To study the vividness of imagery in the chief sense modalities.

Materials

Galton's questionnaire with the rating scale.

Procedure

1. Ask S to get mental images of his mother's face, his study room, etc.

2. Instruct him regarding the meaning and use of the rating scale.

3. Give the questionnaire and ask him to call up an image, if possible, of each object or situation and use the rating scale to estimate the vividness of each image.

Results

1. Compute the average vividness score for each sense. Show these results by a bar diagram.

2. Obtain the class data, compute the mean for each sense for the group and draw a bar diagram.

3. Study the group results to find out the variation in vividness among the individuals.

4. Study the group results to find the variation in vividness among the different sense modalities. Why do some fields give high values?

5. Is there any evidence for 'imagery types'?

(b) Speed of imaging

Problem

To study the variations in the speed with which images occur.

Materials

Prepare for each sense modality a list of twenty items; stop-watch.

Procedure

Ask S to make a clear mental image of each item. He must wait till he gets a clear image; then he ticks it off and proceeds to the next. The time allowed is one minute.

Results

1. Determine how many items give rise to images in each sense modality in your S.

2. Study the variations. Prepare a bar diagram.

3. Collect the class data and compute the mean for each modality.

4. Is there any relation between vividness and the speed of obtaining images?

(c) Control of imagery

1. Obtain the various modes of imagery in respect of a close friend who is not working with you in the group (visual images of the face, general physique, clothes, etc., auditory images of voice in speaking, singing, etc., tactual images, etc.).

2. Can you inhibit imagery? Can you think of the friend without having visual, auditory and tactual images?

3. Which is the most difficult to inhibit and which the easiest? Why?

Table to record the vividness of images for each modality

	V	A	Ol	G	T	K	Th	Org
5								
4								
3								
2								
1								

(V = Visual, A = Auditory, Ol = Olfactory, G = Gustatory, T = Tactual, K = Kinæsthetic, Th = Thermal, Org = Organic.)

Individual Experiment Experiment 35

Motor tests

Problem

To study some methods of measuring motor skills.

Materials

Hand dynamometer, tapping board and stylus, steadiness tester, precision board; electric counter, key, batteries, stop-watch.

Procedure

(a) *Strength of grip*

1. S grips the dynamometer and pulls as hard as possible with right hand. E records the amount of grip indicated by the position of the hand on the dial.

2. After 10 seconds rest S pulls with left hand. Make three trials like this for each hand.

(b) *Speed of movement*

1. Connect the electric counter with tapping board and stylus or with an electric key. Ask S to tap as fast as possible with his right hand for 10 seconds.

2. After 10 seconds' rest S taps with his left hand. Make three trials like this for each hand.

(c) *Steadiness of movement*

1. Connect the electric counter with the steadiness tester. Instruct S to insert the point of the stylus in the largest hole. After 15 seconds ask him to withdraw it. Note the number of contacts made from the counter.

2. After 10 seconds' rest repeat the procedure with the next largest hole.

3. Proceed like this till he has been subjected to a 15-second test with each of the 9 holes of varying sizes from the largest to the smallest.

4. Take readings for his left hand also (the readings are better taken alternately for the two hands).

(d) *Precision of movement*

1. Connect the electric counter with the precision board. Let S start at the wide end of the groove and trace to the narrow end. See that he moves at least 5 cm. per second. Time him with a stop-watch. Note the number of contacts on the counter.

2. Ask him to trace with his left hand. Take ten readings with each hand alternately.

Results

1. Tabulate the results for your subject in each of the four tests for each hand.

2. Determine S's index of right-handedness, by calculating his left hand efficiency as a percentage of his right hand efficiency.

3. Tabulate the scores made by the different individuals in the group and find the mean and SD.

4. Find the correlation between the tests using the rank difference method. What is the inference?

Table to record the results of a motor test

Strength of Grip

Trial	*Right hand*	*Left hand*
1		
2		
3		
Sum		
Mean		

(Similar tables should be drawn up to record the results of the other motor tests.)

Individual Experiment Experiment 36

Fatigue

Problem

To measure the changes which take place with continuous work.

Materials

A sheet of paper with vertical columns; stop-watch.

Procedure

1. E calls out a number. S is instructed to add 2 to this number and write the total in the column of the sheet of paper provided. S then adds 3 to the total and writes it below. He adds 4 to the previous total and writes the number. Next he adds 5. After this he again starts by adding 2 and goes up to 5 and enters in the column. He continues like this till he is asked to stop by E.

e.g., If E calls out the number 11 S will have to write the following numbers in the column: 13, 16, 20, 25, 27, 30, 34, 39, 41, 44 and so on.

2. At the end of 30 seconds E calls out a new number and S has to work in the second column.

3. Take 30 readings like this for 15 minutes.

4. S is to work as rapidly as possible without any break.

5. E and S exchange places.

6. In the next series S should work in the same manner as above but with this difference. He should not vary his bodily posture throughout the 15 minutes. He should keep the same position of trunk, limbs, head, etc.

7. E and S exchange places.

Results

1. Construct a curve showing the number of additions in each successive 30-second period and another curve to show the number of errors.

2. Is the decrease in efficiency shown more in speed or in accuracy?

3. Study the individual differences.

4. Plot the work and error curves for the class as a whole.

5. In what way does your own curve differ from that of the group?

6. How does inhibition of bodily movement affect the onset of fatigue?

7. Are these differences statistically significant?

LEARNING

Individual Experiment — Experiment 37

The learning of a motor pattern

Problem

To study the processes by which new patterns of movement are organized.

Materials

A slot maze with blind alleys marked by alphabets; stylus; stop-watch.

Procedure

1. Blindfold S and ask him to hold the stylus, which is placed at the starting point.

2. Give him the following instructions: 'You are to move along the slot till you reach the goal, where you will be able to lift the stylus out of the pattern. Try to reach the goal as quickly as you can.'

3. Note the time taken to do each trial.

4. Note the name of each blind-alley into which he goes. This will give a record of the number and nature of errors in each trial.

5. At the end of each trial ask him to give introspections on the following points:

(i) Any conscious plan to solve the problem.

(ii) Any imagery—visual, kinaesthetic, etc.

(iii) Any emotional disturbances—blocking, anger, helplessness, tension, relaxation, satisfaction, hope, etc.

(iv) How are the errors being eliminated?

6. Continue the trials till S runs the maze without errors twice in succession.

Results

1. Plot a time curve.

2. Plot an error curve.

3. From the errors find out the manner in which the blind alleys are eliminated. Which alleys are eliminated first: (*a*) those near the starting point, (*b*) those near the goal or (*c*) those in the middle; and which are the last to be eliminated?

4. Analyse the introspective reports and find out the role played by any conscious plan in learning the maze.

5. Did imagery occur? Was it of any use?

6. What role do emotions and feelings play in learning? Do you find any evidence for Thorndike's law of effect?

7. Collect the group data and calculate the average time and errors for each trial. Plot the curves.

8. Study the individual variations. How do your curves compare with the group curves?

LEARNING

Individual Experiment Experiment 38

Mirror drawing

Problem

To study the establishment of a new spatially co-ordinated activity.

Materials

Mirror drawing board with screen; copy of star pattern ,with double line; wooden stylus; carbon paper and blank paper (as an

alternative the pattern may be printed and 12 copies supplied to each S); stop-watch.

Procedure

1. Place the pattern in such a way that the star can be seen only through the mirror.

2. Give the following instructions: 'Trace the pattern from the point shown, along the direction indicated by the arrow seen in the mirror. Trace as quickly as possible. Be careful to see that you are between the two lines. Each contact with or crossing of the lines is an error. Return to the centre of the path as quickly as possible.'

3. In the first trial ask S to trace the pattern with his left hand. Note time and errors.

4. Next ask him to trace the pattern with his right hand. Give 10 trials.

5. In the last trial ask him to trace with left hand once again.

6. Take introspection after each trial regarding the points of difficulty, the more difficult and the more easy parts of the pattern. What is the confusion caused by the mirror space?

7. Take three more tracings with the right hand a week later, without any further practice, to study the effect of lapse of time and the savings in the number of trials.

Results

1. Draw the time and error curves.

2. Collect data for the whole group, compute average time and errors for each trial and draw the curves.

3. What is the percentage improvement with the right hand from the first to the last record?

4. What is the percentage improvement with the left hand from the first to the second record? Why has this improvement occurred?

5. Compare the re-learning scores with the original learning scores. What are the causes for the difference, if any?

6. Analyse the introspective data.

Experiment 38

Table to record time and errors in mirror drawing

(Trials A *and* B *are made with the left hand)*

Trial	A	1	2	3	4	5	6	7	8	9	10	B
Time												
Errors												

Table to show the effect of lapse of time

	First week			Following week			*Percentage lost*	*Percentage saved*
	First trial	*Last trial*	*Average*	*First trial*	*Last trial*	*Average*		
Time								
Errors								

Individual Experiment Experiment 39

Letter-digit substitution

Problem

To study the way in which verbal associations are built up in the substitution test.

Materials

Letter-digit substitution test; stop-watch.

Procedure

1. Place ten sheets, face downward, before every subject.

2. Give the following instructions: 'At the signal from E write beneath each number the letter indicated in the key. Work as quickly as possible. At the signal "stop" put this sheet down and be ready to start work on the second sheet.'

3. Give a sample with letters and digits other than those used in the test.

4. Each trial lasts for 30 seconds; give a rest for 30 seconds between trials.

5. Take introspection regarding difficulty or ease of building up the association.

Results

1. Count the number of substitutions made in each trial and plot the learning curve.

2. Study the nature of errors committed and how they are eliminated from trial to trial.

3. Take the average number of substitutions per trial for the group and plot the curve.

4. Compare the curves for the three kinds of learning—slot maze, mirror drawing and letter-digit substitution.

LEARNING

Individual Experiment — Experiment 40

Motivation

Problem

To study the effect of punishment on 'mirror groove' learning.

Materials

Mirror groove pattern with stylus; electric counter; inductorium with electrode to give shock; battery; stop-watch.

Procedure

1. Connect the board with the electric counter and inductorium in such a way that when the stylus touches the edge of the groove the error will be recorded and a mild shock administered to S's left hand with which he grasps the electrode.

2. Give six trials with shock and six without, the trials coming alternately. Let half the group start with shock and the other half without.

3. Note the time and number of errors for each trial and whether it is with or without punishment.

Results

1. Collect together the trials with punishment and the trials without punishment.

2. Draw the time and error curves for the individual as well as the group (average per trial).

3. What is the effect of punishment on learning? Does it retard or facilitate or make no difference? Study its effect upon each individual in the group.

4. Why are the trials with and without punishment made to alternate? Which is the better procedure for obtaining data for the problem?

Individual Experiment Experiment 41

Role of insight in learning

Problem

To study the difference between trial and error learning and learning from insight.

Materials

Two step mazes (a series of rows of brass screws mounted on a board); stylus with metal point; electric counter or buzzer; battery; stop-watch.

One maze is so wired that there are systematic turnings and a definite number of screws at each turn. The other has no such definite pattern, but both involve the same number of screws from start to goal. The maze is connected with the counter and stylus in such a way that when the stylus touches the correct screw there is no contact. Any screw that is not on the path will complete the circuit when touched by the stylus.

Procedure

1. Give the following instructions: 'Start from the screw indicated and try to reach the screw encircled by a white line at the top. Every screw head looks exactly like any other, but the screws are so wired that there is a correct path. If you go step by step on these screw heads you will reach the goal without any error. If you place the stylus on any other screw the counter will work. A clicking sound is made and an error is recorded. Observe the following rules:

(i) Go from one screw to the next step by step without skipping.

(ii) You must move to the next screw to the right or left, above or below. Never go diagonally.

(iii) When you go to a wrong screw, retrace to the correct screw from which you went and try again.

2. Let half the class start with the pattern with systematic turnings and then go on to the pattern without system; the other half *vice versa*.

3. Note the time and error for each trial.

4. Proceed till S reaches the goal without any errors in two successive trials.

5. Take introspection after both the series are learnt. What is the difference between the two paths?

Results

1. Plot the time and error curves for the two patterns.

2. Collect the data for the whole group and find out the average number of errors and time for each trial.

3. Which pattern is learnt quicker with fewer trials, in less time and with fewer errors?

4. Analyse the introspective data and find how many SS were able to formulate the design of the systematic pattern.

5. What is the influence of relation-eduction (insight) upon learning?

LEARNING

Individual Experiment Experiment 42

Conditioning

Problem

To study some of the principles involved in simple conditioning.

Materials

Air puff tube (a metal tube about 8″–10″ long with a rubber bulb attached so that air can be puffed); stand and clamp; metre rod.

Procedure

1. Adjust the tube in such a way that a puff of air can be sent to the eye. The intensity of the puff can be adjusted by varying the distance between the eye and the tube.

2. Say 'ready', or ring a bell, and blow the air. The unconditioned stimulus is the puff and the response is blinking of the eye. The incidental stimulus is the sound of the bell.

3. Give both stimuli ten times. Then ring the bell without the puff. If no response occurs press bulb and give a puff, thus compelling the response.

Give the paired stimuli a few more times and then give the sound alone. When the response is elicited by the sound alone twice in succession it may be considered that the reflex is partially conditioned.

4. Record the stimuli and responses using the following notations: UR unconditioned response; CR conditioned response; NR no response; US unconditioned stimulus; CS conditioned stimulus.

5. Continue the paired stimulations a little longer and give a number of successive stimulations with the sound alone in order to discover how long the conditioning will last without reinforcement by the unconditioned stimulus (experimental extinction).

Supplementary Procedure

1. Vary the intensity of the unconditioned stimulus by bringing the tube nearer to or taking it farther from the eye and note down the number of trials necessary to establish conditioning at the varying distances.

2. Using the inductorium and buzzer or bell and kymograph follow the procedure detailed above and study the number of trials necessary to establish conditioning of the withdrawal reflex.

Results

1. Find how many trials were necessary to establish the conditioning in each S.

2. Collect the class data and find the average.

3. What is the effect of varying the intensity of the unconditioned stimulus?

MEMORY

Individual Experiment — Experiment 43

Memory span

Problem

To determine the immediate memory span of an individual.

Materials

A list of numbers containing from five to ten digits. Prepare the list in such a way that there are two numbers at each step: two of 5 digits, two of 6, and so on.

Procedure

1. Ask S to write down the numbers you call out.

2. Pronounce the numbers in an even tone.

3. Start with the first 5-digit number. If S repeats it correctly go to the first 6-digit number, and so on.

4. If he fails to repeat a number correctly then give him the second one of the same length. If he succeeds go to the next step.

5. Stop when you get two successive failures, i.e. when both the numbers of a particular length are incorrectly reproduced.

Results

1. Calculate the span on the basis of the longest number correctly reproduced after *one* presentation.

2. What is the mean span for the group?

3. Study the individual variations.

4. See whether there is any relation between immediate memory span and marks in class examinations.

MEMORY

Group Experiment Experiment 44

Memory for names and faces

Problem

To study the individual differences in memory for names and faces and to study the methods used in associating the two.

Materials

A set of ten photographs with names and numbers; another set of the same with numbers only; stop-watch.

Procedure

1. Give the following instructions: 'You will be shown a set of ten photographs with names and numbers. You will have to reproduce the numbers of the photographs when the names are given to you later.'

2. Expose the ten numbered and named photographs on the wall, directly or through an epidiascope, for one minute.

3. Engage the class in some other experimental work for some time.

4. Give the list of names. Expose the same pictures again without names and in a different order. Ask them to note against each name the number of the picture.

5. Ask them to note down what procedure each used to associate the name with the face.

Results

1. Find out how many responses are correct for each person.

2. Calculate the average for the group.

3. Analyse the responses to find out if there is variation from picture to picture or if the total responses are about the same for each.

4. Analyse the procedures used and see if there is any relation between the procedure adopted and the number of correct responses.

5. How can we improve the memory for names and faces? What are the vocations where a good memory of this kind is necessary?

MEMORY

Individual Experiment

Experiment 45

Rote and logical memory

Problem

To determine the difference between memorizing nonsense syllables and words, and to illustrate two methods of studying recall.

Materials

An exposure apparatus; lists as follows: (i) 10 words, (ii) 10 nonsense syllables, (iii) 10 pairs of words, (iv) 10 pairs of nonsense syllables, (v) the first word of each pair in List iii but in different order; (vi) similarly the first nonsense syllables of List iv; metronome; stop-watch.

Procedure

(a) *Ordinary recall*

1. Half the class learn the word list first and the other half the nonsense syllables first.

2. Give the following instructions: 'You are to observe the

list as the items are exposed. After the list has been exposed you have to write the items in the order in which they were exposed.'

3. Expose the list item by item. Allow one minute for recall. Note the responses and check.

4. Repeat the procedure till the entire list is reproduced in the correct order and note the number of trials and the number of correct responses in each trial.

5. Repeat the experiment with the second list (nonsense syllables or the words, according to which was learnt first).

(b) *Recall of paired associates*

1. Instruct S that he has to respond with the second item in the pair when the first is shown. He must be informed that the material will be presented in a rearranged order.

2. Follow the same procedure as above for presenting the stimuli for learning.

3. Expose the paired associates ten times. Do not take the responses at the end of each trial.

4. After ten trials present the first member of each pair in a rearranged order. S has to reproduce the paired associate.

Results

1. How many trials were necessary to learn the list of words and how many to learn the list of nonsense syllables? Plot the learning curves.

2. Calculate the class averages for the two types of material. Plot the learning curve, taking average response for each trial.

3. How many paired associates were correctly recalled in the word series and in the nonsense syllable series? Calculate the averages for the group.

4. What is the influence of meaning on recall?

5. Which of the two recall methods is easier? Why?

6. Compare the learning curves for (i) motor skills (Exp. 37), (ii) nonsense syllables, (iii) words.

Supplementary

Find the difference between recalling a list of unrelated words and a list of related words.

Similarly find the difference using the paired associate method.

IMAGINATION

Individual Experiment — Experiment 46

Ink blots

Problem

To estimate the fertility of imagination in an individual.

Materials

A set of ten ink blots on cards; stop-watch.

Procedure

1. Give the following instructions: 'Look at each blot for one minute. Call out all the things which come to your mind.'

2. Expose one by one the ten cards and note down the responses.

3. Note down also when S starts giving the responses.

Results

1. Calculate the mean time for each response.

2. Calculate the mean number of responses for each S.

3. Collect the group data and find the mean time for the group, mean number of responses for the group and the mean number of responses for each card.

4. Classify the imagery into everyday objects, scientific objects, literary objects and objects from fables and mythologies. Study individual differences.

5. Can you classify the members of the group into (*a*) constructive or imaginative people who put together details in such a way as to form a significant whole, and (*b*) the matter-of-fact or scientific type given more to analysis than to creative synthesis?

Supplementary

1. Give the test to people in different occupations from unskilled to professional people and study the variations in responses.

2. Give the test to people of various age groups and study the variations.

Experiment 46

A. *Table to record data regarding fertility of imagination*

Name	*Number of responses for Ink Blots Nos.*										*Total No. of responses*
	1	2	3	4	5	6	7	8	9	10	
A											
B											
C											
D											

B. *Table showing the qualitative analysis of the responses*

Name	*Everyday*	*Scientific*	*Literary*	*Mythological*	*Other*	*Total*
A						
B						
C						
D						

Group Experiment Experiment 47

Word-building

Problem

To study individual differences in forming words out of letters.

Materials

A list of letters containing three vowels and three consonants; stop-watch.

Procedure

1. Give the following instructions: 'Make as many words as possible from the letters given. You may use any or all of the letters, but do not use the same letter twice in one word. Do not use any letter not given.'
2. Allow five minutes.

Results

1. Check the words and find how many correct responses are given (use a standard dictionary).
2. Find the average number of words for the group.
3. Analyse the responses and find the frequency of each response in the group.
4. Study the individual variations.
5. Find the coefficient of correlation between this test and the ink blots test.
6. Get the class marks in English and in the language of each S and find correlation with this test.

Group Experiment Experiment 48

Sentence construction

Problem

To investigate the constructive ability of the subject in linguistic material.

Materials

Three cards each containing three nouns; three cards each containing three verbs; stop-watch.

Procedure

1. Give the following instructions: 'You will be given three nouns (or verbs). Construct as many sentences as possible using each one of the three nouns. You may use other nouns.'

2. Give five minutes for each card.

Results

1. Find the number of sentences constructed.

2. Find the number of words used in each sentence.

3. Find the average number of sentences and average number of words per sentence, for nouns and verbs, for the group.

4. Study the difference between nouns and verbs.

5. Study the individual variations.

6. Find the coefficient of correlation of this test with the other two tests in this section.

7. Is there any difference between verbal and non-verbal imagination?

8. Find the correlation between this test and marks in English.

Supplementary

1. Give this and the word-building test to the students in the various classes in the High School and College and study the variation in performance.

2. Study also the relationship between these tests and class marks in English and class marks in Indian languages.

THINKING AND REASONING

Group Experiment — Experiment 49

Concept formation

Problem

To study the process by which concepts grow and to study the processes of abstraction and generalization.

Materials

25 Picture post cards or geometric figures, in five sets of five cards; each set has some characteristic feature common to all five

pictures, and which is designated by a meaningless syllable written on the back of each card in the set; stop-watch.

Procedure

1. Give the following instructions: 'In the cards there are groups of pictures. Each group is given a name. You have to learn what this name represents by looking at the pictures as they come.'
2. Shuffle the cards. Give one face upwards to each member of the class and place the rest near the first student.
3. At a signal from E each S turns the card and looks at the nonsense syllable at the back. At another signal he passes the card to his neighbour face upwards.
4. From time to time E collects the cards from the last student and places them near the first student.
5. After each student has seen all the 25 cards E reads out the nonsense names one by one and asks SS to write what each name means.
6. Ask SS to write introspection regarding the way in which the word acquired meaning.
7. Give a second exposure and at the end ask them to complete a universal proposition regarding each name.
8. Ask SS to write introspection regarding the growth of a general concept.
9. After a third exposure ask them to complete a particular proposition regarding each name.
10. Take further introspection accounts.

Results

1. Check the results and find how many were able to get correct responses after the first trial, second trial and third trial.
2. Analyse the introspective data and find the way in which concepts grow.

THINKING AND REASONING

Individual Experiment — Experiment 50

Controlled association

Problem

To study the factors underlying controlled thinking and the differences between the various kinds of controlled associations.

Materials

List of 20 stimuli each for the following associations: (i) whole–part, (ii) species–genus, (iii) attribute–substance, (iv) opposites; stop-watch.

Procedure

1. Give the following instruction at the beginning of each list: 'When you hear the word, give the part which belongs to the whole.' (The appropriate relation should be mentioned in each series.)

2. Note the response and the time by stop-watch.

3. Proceed in this manner with the other lists.

4. At the end of each list ask S to take introspection regarding the following: (i) conflicting association due to habit, (ii) multiplicity of choice, (iii) occurrence of imagery and whether it was helpful.

5. After all the lists are over ask him if he was aware, as he was working, what sort of association he had to give when he heard each word in a given list.

Results

1. Note the average reaction time for each kind of association for each S and for the group as a whole. Prepare a bar diagram for your results and the results of the group.

2. Analyse the introspective data and find if there is any relationship between the occurrence of extraneous associations and delay in response.

3. From the introspective data is there any evidence for 'Set'?

4. Can you say just what happens between the stimulus and response and how you get the response?

Alternative Procedure for a Group Experiment

1. SS are provided with a list of 20 stimulus words for each association, (face downwards) one set at a time.

2. E gives instructions regarding the nature of the response.

3. At the given signal SS have to turn the paper and start writing the response for each stimulus.

4. After 40 seconds E asks them to stop working.

5. The average time for each response for each S is then calculated.

Individual Experiment Experiment 51

Problem-solving

Problem

To study the processes involved in the solution of a problem.

Materials

Series A: wire puzzle (heart and bow).
Series B (placement problem): cut-out parts for T-puzzle.
Series C (rational learning): letters and numbers.
Stop-watch.

A. Wire Puzzle

Procedure

1. Give the following instruction: 'You have to remove the heart-shaped piece from the bow.'

2. Note the time taken and observe the behaviour of S from start to finish. Note in particular the movements of his hands, facial expression and verbal expression. Note further whether the solution occurred by chance or with insight.

3. Ask S to give an introspective report of the steps taken to solve the puzzle and how the solution occurred.

4. Give five trials altogether and note the time and details of behaviour. Ask him to give an introspective report after the fifth trial.

Results

1. Draw the learning curve for your S as well as for the group as a whole.

2. Collect the individual data and study whether the solution occurred by trial and error or by insight.

3. Analyse the notes of behaviour.

4. Analyse the introspective account.

5. What is the role of emotion in problem-solving?

6. What is the role of trial and error in problem-solving?

B. T-PUZZLE

Procedure

1. Give the following instruction: 'From the four pieces given construct the letter T.'

2. Note time and behaviour as in the previous series. Also ask S to give his introspection.

3. Give five trials altogether and note his introspection after the last trial.

Results

1. Treat the data as in Series A.

2. Analyse the observational and introspective data.

C. CODE PUZZLE

Procedure

1. Take the first ten letters of the alphabet and assign to each a number from 1 to 10, a random order. Do not reveal these numbers. S has to guess and find out.

2. Call out the letters in alphabetical order one at a time. Ask S to guess the correct number between 1 and 10 associated with each.

3. For each letter record the responses given by S. When he hits upon the correct number say 'right', and proceed to the next letter.

4. Note 'L' against an erroneous response if it is a number already established as a correct response (logical error). Note 'P' if he repeats the same wrong number in a given series (perseverative error). All other responses are unclassified errors.

5. Stop the trials when two correct series in succession have been achieved.

6. Take an introspective account at the end.

7. Record the number of trials, total number of errors of each kind and total time for each trial.

Results

1. Draw the curves for errors and time for each individual and for the group as a whole.

2. Analyse the errors and draw up a table for the group.

3. Analyse the introspective data.

4. Find the correlations between the three tests and draw conclusions from the data.

Experiment 51 (C)

Tables to record the data obtained in Peterson's Test of Rational Learning

Individual data

Trial	*Logial errors*	*Perseverative errors*	*Unclassified errors*	*Total errors*
1				
2				
3				
4				
5				
Total				

Group data

Individual	*Total No. of trials*	*Logical errors*	*Perseverative errors*	*Unclassified errors*	*Total errors*
A					
B					
C					
D					

Group Experiment Experiment 52

Bias in reasoning

Problem

To study the influence of retentive and emotional bias in reasoning.

Materials

A set of 12 syllogisms, 6 with valid conclusions and 6 with invalid conclusions. Among the 12 syllogisms 6 have conclusions with emotional bias (3 for and 3 against) 6 have conclusions with retentive bias (3 for and 3 against).

Procedure

This should be conducted as a group experiment. E should distribute the sheets with syllogisms to the subjects with the following instructions: 'Go through each argument and see whether the conclusion follows from the two statements. Give a reason if you think the conclusion does not follow.'

There is no time limit.

Results

1. Find out how many conclusions with bias 'for' are accepted and how many with bias 'against' are rejected.

2. Find out how many invalid conclusions are accepted and how many valid are rejected.

3. Determine the influence of emotional bias and retentive bias upon reasoning.

4. Collect the class data and construct a bar diagram.

5. Analyse the reasons given.

Experiment 52

Table to record the errors committed in syllogistic reasoning

Names	*Total errors*	Emotional bias		Retentive bias	
		Against	*For*	*Against*	*For*
A					
B					
C					
D					
Total					
Average					

Individual Experiment — Experiment 53

Performance tests of intelligence

Problem

To test an individual's intelligence by means of a scale of performance tests.

Materials

Alexander's scale of performance tests: (i) pass-along test with designs, (ii) Koh's block design test with designs, (iii) cube construction test; stop-watch.

Procedure

1. As given by Alexander in his *Intelligence—Concrete and Abstract*.

2. The instructor can test two of the subjects and they can test two more. No S should give the test before he has himself taken it.

Results

1. Calculate the scores according to directions and find the mental age of each S (use code to avoid identification).
2. What is the mean mental age for the group?
3. Find the correlations between the three tests.

Group Experiment — Experiment 54

Group verbal test

Problem

To test an individual's intelligence by means of a group verbal test.

Materials

A standard group verbal test, e.g. American Army Test, Terman's Test, Spearman's Test or Ballard's Chelsea Test.

Procedure

Adopt the standard procedure. The instructor distributes the blanks and conducts the test.

Results

1. The students can mark the test according to the directions and find the score.
2. Compare the score of each S with the norms.
3. Calculate the average for the group.
4. Find correlations between the various sub-tests.

INTELLIGENCE

Group Experiment — Experiment 55

Group non-verbal tests

Problem

To measure an individual's intelligence by a group non-verbal test.

Materials

A standard test such as the American Army Beta Test, Sleight's Non-Verbal Test or the National Institute Group Test.

Procedure

The instructor will adopt the procedure of the particular test according to directions and administer the test to the group.

Results

1. Calculate the scores for individuals and the average score for the group and compare with the norm.
2. Find correlation between sub-tests where possible.
3. Find correlations between the scores for the performance of verbal and non-verbal tests and draw conclusions.

INTELLIGENCE

Demonstration Experiment — Experiment 56

Binet Scale

Problem

To measure an individual's intelligence by the Binet Scale.

Materials

Use Terman-Merril Test or Rice-Binet Hindustani Scale or Kamat's Scale.

Procedure

Follow the procedure indicated by the particular author.

Results

Score and find the mental age and calculate the I.Q.

PERSONALITY TRAITS

Group Experiment — Experiment 57

Introversion—extroversion

Problem

To measure the tendencies toward introversion of a given individual.

Materials

A standardized introversion—extroversion test.

Procedure

1. The instructor will administer the test, according to the standardized procedure, to the group as a whole.
2. SS will score their own reactions according to the information provided by the instructor.
3. The significance of the score of each will be noted according to the norms.

Results

Draw the distribution curve for the group.

Group Experiment Experiment 58

Ascendance—submission

Problem

To measure the ascendant reaction of a given individual.

Materials

Allport's A-S Reaction Test.

Procedure

1. The instructor will administer the test, according to the directions. to the group as a whole.
2. SS will score their own reactions according to the information provided.

Results

Draw the distribution curve for the group.

Group Experiment Experiment 59

Neurotic questionnaire

Problem

To study the variations in the control of emotional life among the individuals in the group.

Materials

Standardized questionnaire of Woodworth or Bernreuter.

Procedure

The instructor will follow the directions and conduct the test on the group.

Results

The responses are checked by SS according to the information supplied by the instructor, and the individual variations are discussed.

INTERESTS AND APTITUDE

Group Experiment Experiment 60

A. Vocational interest test

Problem

To study the variations in the vocational interests among the individuals of a group.

Materials

A modification of Strong's Interest Scale.

Procedure

The instructor administers the test according to the directions.

Results

With the help of the information supplied by the instructor analyse the responses and write a note about the interests of each member in the group. Tabulate.

B. Test of interest in science and arts subjects

Problem

To study the variations in the educational interests among the individuals of the group.

Materials

A modification of Hazlitt's Test.

Procedure

The instructor administers the test according to the directions.

Results

Analyse the responses with the help of the information supplied by the instructor and write a note about the interests of each member in the group. Tabulate.

Group Experiment Experiment 61

Other aptitude tests

Problem

To study the variations in some aptitudes.

Materials

1. Mechanical aptitude tests.
2. Clerical aptitude tests.
3. Musical aptitude tests.

Procedure

The instructor will conduct the tests, according to directions, on the group as a whole.

Results

He will provide information to score the responses.

Using the information, draw up a note regarding each member of the class.

Put down the results of the measurements of intelligence, personality traits, interests and aptitudes and write a consolidated note about each individual in the group; then compare with the notes drawn up by the other members in the group.

Appendix A

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Some of the firms in India which manufacture and supply psychological apparatus:

Scientific Instrument Co., 30 Mount Road, Madras
Biological Supply Concern, 5-A Kali Datt Street, Calcutta 5
Purohit & Purohit, 431/43 Sukrawar, Poona
Young India Model Industries, No. 8, Ramanuja Road, Chamundipuram, Mysore
Bharath Model Industries, Jalapuri Extension, Mysore
Physiological and Psychological Apparatus Manufacturing Co., (Hasan Gunj), Fyzabad Road, Lucknow
Adair Dutt & Co., Post Box No. 327, Mount Road, Madras
Scientific Instrument Co., Allahabad
Instruments and Chemicals Ltd., Ambala Cantt.

Appendix B

NOTES FOR INSTRUCTORS

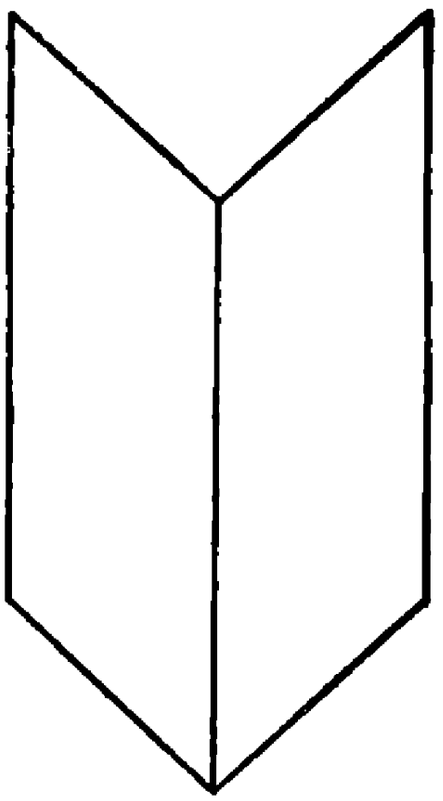
Experiment 1. The attention of S should be directed towards his experience so that he can learn to introspect and know what introspective method is. The attention of E should be directed to the observation and verbal record of S's behaviour.

Experiment 2. The picture should have a number of details: an ideal picture would be that of two or three human beings in a natural setting with one or two animals.

Experiment 3. For more detailed instructions regarding material and procedure see Whipple II, Test 32.

Experiment 5. The winking glass apparatus consists of a thick glass window; attached to the frame is a felt hammer which flies up and strikes the glass in front of S's eyes.

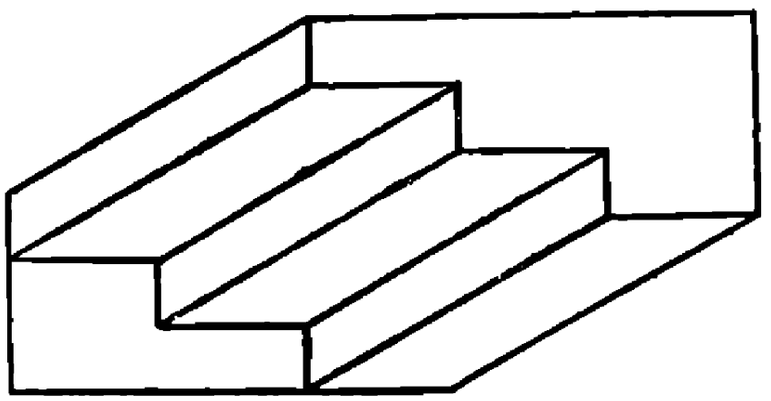
Experiment 6. The knee-jerk apparatus consists of a cross-bar fitted to a frame over which S places his thigh, suspending his foreleg. A hammer is let fall below the knee-cap to produce the jerk reflex. The response can be measured with the help of a wooden rod attached to the foot. (See *Journal of Experimental Psychology*, Vol. II [1928], pp. 468-494 and Vol. XVII [1934], pp. 556–573).



Book Figure

Experiment 8. See Rosanoff: *Manual of Psychiatry*, pp. 547–620 for the Kent-Rosanoff word list, frequency tables, etc.

Experiment 12. The letter-cancellation sheet has the alphabets printed in capitals. S is asked to cross out every A, E and O in



Reversible Stairs Figure

the sheet. The greater the number of letters chosen the greater the mental effort.

Each letter of the alphabet occurs the same number of times on the page as any other letter, so it does not matter which letter is chosen.

S must take care to put his pencil mark right through the letter (see Valentine, op. cit., pp. 77–78).

EXPERIMENT 13. One of the following reversible figures could be drawn on a plywood board with the help of a local artist:

(a) book figure, (b) reversible stairs (see illustration on p. 130).

EXPERIMENT 14. The tachistoscope is a short-exposure apparatus. There is an aperture in the middle of the front board on which S has to fix his attention. The test material is drawn on a set of blank post-cards each of which could be fitted into the exposure card-holder at the back. There is a falling shutter behind with an aperture in the middle and a white field of the same size as the aperture above and another below. The shutter is raised and held by a catch at the top. The card is fitted. When the shutter is dropped the material in the card is exposed for about a tenth of a second.

The essentials of a good tachistoscope are: (i) the exposure must be short enough to preclude eye-movements; (ii) the exposure of all parts of the field should be simultaneous.

EXPERIMENT 17. Purchase six sheets of coloured paper: red, yellow, green, blue, purple and pink. Cut one inch square of each colour to serve as the figure. Also cut larger sheets 7″ by 10″ of each colour to serve as background. All these pieces, big as well as small, may be mounted on cardboard to last longer. A big grey sheet 15″ by 20″ mounted on cardboard may be used as a general background throughout the experiment.

The colour wheel may be prepared by taking two cardboard or plywood discs of 6 inches diameter on which the six colour squares are pasted. On the top of these two discs a rectangular cardboard or plywood board is fixed with one-inch square windows on either side so that by rotating the two discs we can study the colour preference of S using the paired comparison method.

EXPERIMENT 18. The standard Feleky set may be obtained from Teachers' College, Columbia University. (*Psychological Review*, Vol. XXI, [1914], pp. 33–41).

The 14 pictures used by Langfeld (*Journal of Abnormal Psychology*, Vol. XIII, pp. 171–183) and reproduced in several textbooks and laboratory guides may also be used.

EXPERIMENT 19. The Boring-Titchener model with cut-out pieces: brows (4), nose (2) eye (5), and mouth (9). (See Boring and Titchener, *American Journal of Psychology*, Vol. XXXIV [1923], pp. 471–485 and Guilford and Wike, Vol. XLII [1930], pp. 436–439).

EXPERIMENT 20. The pneumograph is a flexible rubber tube which is fastened around the thorax; the breathing of S changes the air

pressure within it. These changes are transmitted to the recording tambour which is another chamber with a rubber membrane on which a light lever rests. The changes of pressure following the inspiration and expiration are communicated by the lever which moves up and down, marking the curve of breathing on the surface of the smoked drum kymograph.

The kymograph is a metal cylinder rotated by clockwork or by a motor. Paper coated with soot by means of a smoky flame is fastened round the cylinder. The time-marker lever and the tambour lever are brought close to the cylinder. As the cylinder rotates the levers make marks. The paper is then cut off the drum and passed through a dish containing a solution of lacquer or shellac with spirit. After drying, the record is permanent and the curves can be studied carefully and measured (see Titchener).

EXPERIMENT 22. The length of the reaction time varies according to the set or the direction of the attention. If the individual directs his attention fully on the muscular response his reaction time will be shorter than if he concentrates on the stimulus he is going to perceive, thinking little of the muscular response he is going to make. Muscular reaction time for light is 175 σ (σ means milliseconds, one thousandth part of a second) while the sensorial reaction time is 270 σ (See Collins and Drever, pp. 157–164.)

In the discrimination reaction experiment two or more visual or auditory stimuli are given. When a green and a red light are used S is instructed to react only to the red light, and should not react to the green light. Here S has to judge which colour is shown before reacting. By subtracting from the average of this series the average time for simple reaction we can obtain the 'discrimination time' which is about 30 σ longer than the simple reaction time.

In the choice reaction time S has two or more keys, depending on the number of stimuli used (note that in the simple and discrimination reaction time experiments S has only one key). He is instructed to press the right key for the green light and the left key for the red light. He may use only one hand, or he may be instructed to use the right hand to press the right key and the left hand to press the left key. The procedure should be predetermined. The choice reaction time is longer than the discrimination reaction time. The greater the number of alternative stimuli used the greater the reaction time.

In the association reaction experiment S sees or hears a word and then responds with the first word that comes to his mind. Association times are considerably longer than the other types of reaction time. Generally the free association time is longer than the time required for controlled association.

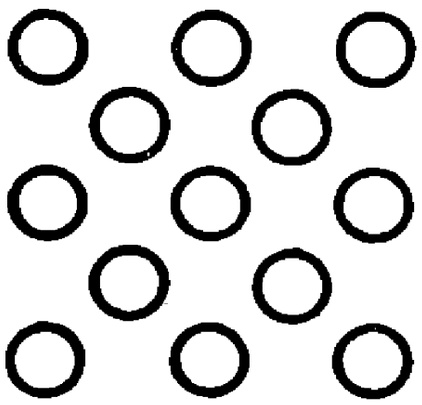
EXPERIMENT 23. This test was devised by Binet to measure suggestibility when it is 'depersonalized', i.e. when it is derived by S from the objective conditions. A certain expectation is roused by the experience, and suggestibility is measured by the ease with which the

suggestion is aroused and by its persistence even when the conditions tend gradually to counteract the expectation.

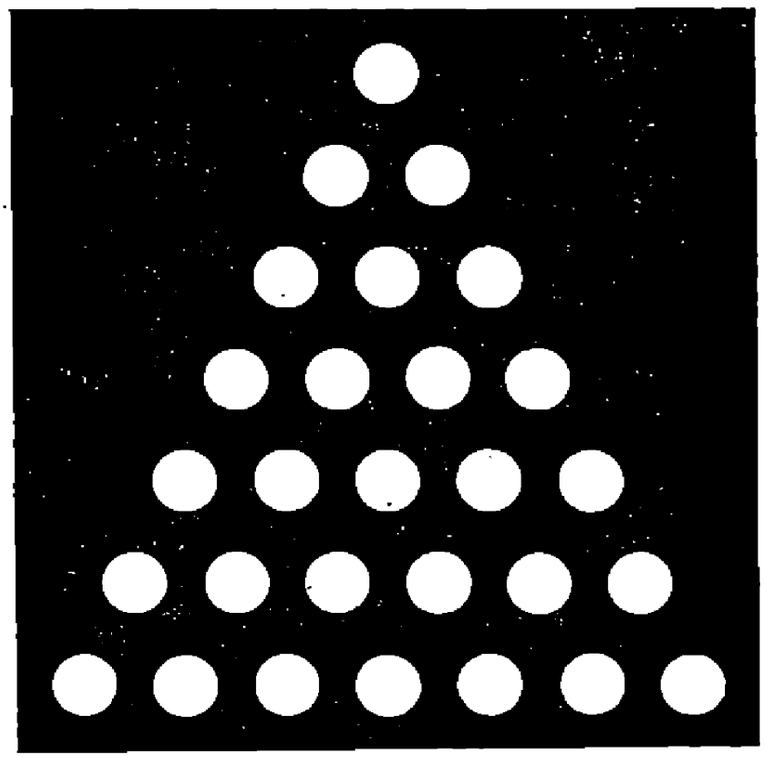
The ten weights are of identical size and appearance and numbered conspicuously from 1 to 10. The first four weigh 20, 40, 60 and 80 grams respectively and the remaining six weigh 100 grams each. (See Whipple, op. cit., Vol. II, pp. 232–236.)

EXPERIMENT 24. The two lamps and the resistance coil are in one circuit so that when the lamps burn the wire becomes heated. During the trial series the secret switch which disconnects the lamp and coil circuit is never used. It is used to disconnect only in the ten trials in the experimental series.

EXPERIMENT 26. The following two figures may be enlarged and drawn on two cardboards or plywood boards so that all the members of the group can see them clearly.



Dot Figure A

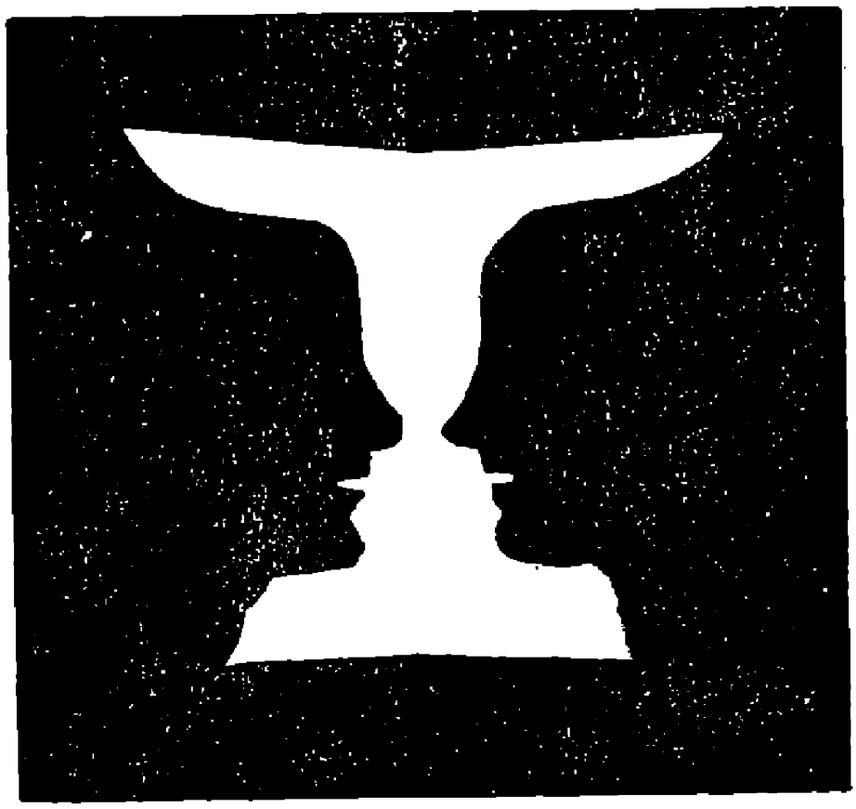


Dot Figure B

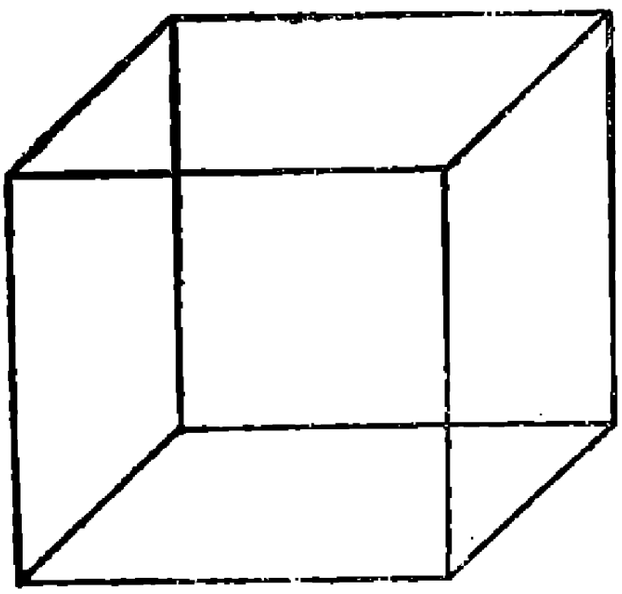
EXPERIMENT 27. The following three figures may be enlarged and drawn on three cardboards or plywood boards so that all the members of the group can see them clearly: vase-face figure, reversible cube figure, star in hexagon figure (see p. 134).

EXPERIMENT 34. The vividness of the imagery is investigated with the help of the following rating scale:

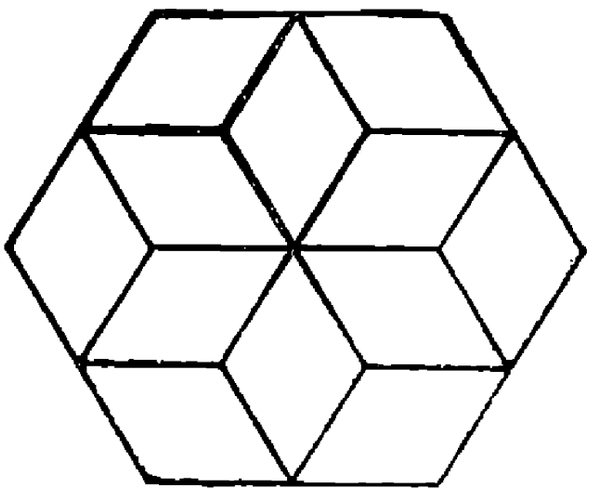
1. Absolutely no image at all.
2. Very vague and dim.
3. Fairly vivid.
4. Vivid.
5. Very vivid.



Vase-Face Figure



Reversible Cube Figure



Star in Hexagon Figure

Give six items for each of the following eight sense-fields. Some items for each sense-field are given below by way of illustration.

1. Visual: two-anna coin, railway engine, elephant.
2. Auditory: barking of a dog, voice of one's best friend, National Anthem.
3. Olfactory: smell of coffee powder, castor oil, sweat.
4. Gustatory: taste of lemon, sugar, quinine.
5. Tactual: smooth glass, sand paper, wheat flour.
6. Kinaesthetic: shaking hands, climbing stairs, kicking football.
7. Thermal: hot bath, cool drink, sultry evening.

8. Organic: stomachache, giddiness, emotional excitement.

See Seashore: *Elementary Experiments in Psychology*, pp. 104–117, (Holt & Co.)

EXPERIMENT 36. The process of addition for each column is illustrated here for three columns with initial numbers 11, 3 and 7.

11	3	7	+3=30	22	26
+2=13	5	9	+4=34	26	30
+3=16	8	12	+5=39	31	35
+4=20	12	16	+2=41	33	37
+5=25	17	21			and so on.
+2=27	19	23			

E must have 30 columns on the sheet of paper given to S and must have 30 initial numbers ready so that at the end of each 30 seconds he gives a new number with which the S has to start working in the next column.

EXPERIMENT 37. The slot maze consists of a path with blind alleys, cut in a thick plywood board. A stylus with a handle and thick edge, which enters at the starting point and comes out of the goal but does not come out of the path, may be used. If the blind alleys are marked by letters a record of the errors can be kept by noting down the blind alleys entered.

EXPERIMENT 39. This test is devised to measure the rapidity with which new associations are formed by repetition. S is provided with a key in which for each letter a number is given. In the test sheets the numbers are printed with blanks for the writing of letters. The connexions indicated by the key are not committed to memory but are acquired gradually by use.

Substitution Test Key

1	2	3	4	5	6	7	8	9	0
g	i	e	k	c	n	d	q	w	r

Test Sheets

5	9	1	2	6	2	7	4	8	0	4	9	6	8	2

3	5	1	7	0	4	8	3	0	9	6	2	7	1	5

EXPERIMENT 43. The memory span for digits is about 5 for ages 7–9 and 6 for ages 10 upwards. To provide for extremes on either side 5–10 digit numbers will be quite enough for college classes. The following list may be used:

7 2 4 6 3
3 8 5 2 9
9 7 2 5 3 8
4 1 8 2 5 3
6 2 5 9 4 1 7
1 5 8 7 4 2 9
2 7 9 3 5 7 4 1
8 3 7 1 4 9 2 5
5 1 4 7 2 8 3 9 6
3 6 2 9 5 8 1 7 4
9 5 1 0 8 3 6 2 4 7
5 7 3 6 1 4 9 0 8 2

EXPERIMENT 44. Ten photographs of people unfamiliar to the group may be chosen. They should be shown first with names and serial numbers, and after an interval the names should be written on the board so that the students can take them down; the pictures should be exposed in a different order but with the same numbers.

EXPERIMENT 45. There are several kinds of exposure apparatus, e.g. Jastrow's, Wirth's etc. Otherwise the kymograph may be used, the material being pasted on the cylinder, and a cardboard with an aperture large enough to expose one word or one pair of words at a time being placed in the front. The essential feature of the exposure apparatus is that one word or one pair of words are exposed each time to S for a definite time so that E can record how many times a list was presented.

A simple exposure device could be made in the classroom in the following manner: Take a long cardboard or thick sheet of paper. In the centre of the board cut a narrow slit through which a word or pair of words may be exposed. Slide this board over the paper containing the list of words at a uniform rate, by timing with a metronome.

EXPERIMENT 46. Whipple's ink blots may be used.

EXPERIMENT 47. Whipple used the following two sets of letters:

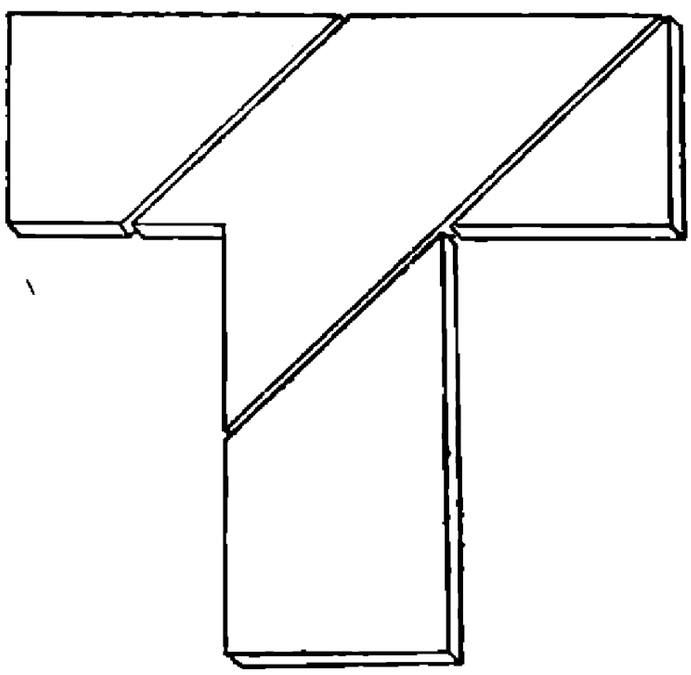
A E O M B T
E A I R L P

EXPERIMENT 49. Twenty-five picture postcards with five sets of five pictures each could be selected. One set of five pictures may have animals in them; the second set may have children; the third, natural scenery with water—river or lake; the fourth, temples; and the fifth, some modes of travel. Each set should have some characteristic common to all its members.

Valentine, who described the materials and procedure for this experiment, used the following five nonsense words for each set of pictures: Funep, Gazod, Benep, Zavos and Batfud.

EXPERIMENT 51. The Heart and Bow wire puzzle consists of a galvanized iron wire bent in a rectangular shape with the two ends turned into circles, and another string bent and tied in a heart shape which can be fitted into the bow and taken out.

The T-puzzle consists of a cardboard or tin "T" which is cut into four pieces as in the accompanying picture:



The code puzzle is Peterson's test of rational learning (*Psychological Review*, Vol. XXV [1918], pp. 443–467).

For illustrative purposes take letters, M, N, O, P and Q and assign to them the following numbers respectively: 3, 1, 5, 4 and 2. Ask an S in the classroom to call out a number for M and go on noting the numbers under M till he calls out 3, announce that he is right and then go on to letter N. The following illustration will help to understand the procedure and the way to classify the errors.

Key	M	N	O	P	Q
	3	1	5	4	2
Trial I	1	2	5	3L	3L
	3	1		2	1L
				1	2
				4	
Trial II	2	4	4	1L	3L
	3	2	3L	2	2
		1	5	3L	
				5L	
				4	
Trial III	3	1	4	4	1L
			3L		2
			5		
Trial IV	3	2	4	4	4L
		1	5		4P
					2
Trial V	3	2	4	4	2
		1	5		
Trial VI	3	1	5	4	2
Trial VII	3	1	5	4	2

Analysis of Errors

Trial	*Logical error*	*Perseverative error*	*Unclassified errors*	*Total errors*
I	4	0	3	7
II	5	0	5	10
III	2	0	1	3
IV	1	1	2	4
V	0	0	2	2
Total	12	1	13	26

Refer to the Table of Norms given by Peterson (*Journal of Applied Psychology*, Vol. IV [1940], p. 254) and find out the relative position of each individual in the group.

EXPERIMENT 52. Dr D. Ramakrishnia studied the influence of bias on reasoning at Mysore University. He framed a number of syllogisms, half of which were valid and half invalid. He analysed bias into four types: emotional bias for the conclusion and emotional bias against the conclusion; retentive bias for the conclusion and retentive bias against.

Here are 12 syllogisms copies of which may be given to the students. At the end a key is given by which the answers of the students may be checked.

1. All dacoits are dangerous to society.
   All dacoits are murderers.
   ∴ All murderers are dangerous to society.

2. All thieves are criminals.
   Patriots are not thieves.
   ∴ Patriots are not criminals.

3. All cultured men are truthful.
   Most lawyers are cultured.
   ∴ Most lawyers are truthful.

4. All pious persons are fanatics.
   No Hindus are fanatics.
   ∴ No Hindus are pious.

5. All Hindus belong to Asia.
   All Hindus are Indians.
   ∴ All Indians belong to Asia.

6. All selfish men are pleasure-seekers.
   Most misers are not pleasure-seekers.
   ∴ Most misers are not selfish.

7. All beautiful girls are fashionable.
   Some actresses are fashionable.
   ∴ Some actresses are beautiful.

8. Civilized men are materialistic.
   Most Indians are not materialistic.
   ∴ Most Indians are not civilized.

9. Narrow-minded men never attain greatness.
   Patriots are narrow-minded.
   ∴ Patriots never attain greatness.

10. All superstitious men are timid.
    No old men are timid.
    ∴ No old men are superstitious.

11. All labourers are poor.
    Money-lenders are not labourers.
    ∴ Money-lenders are not poor.

12. All smooth things are slippery.
    Many glass plates are slippery.
    ∴ Many glass plates are smooth.

Key

Valid 3, 4, 6, 8, 9 and 10.
Invalid 1, 2, 5, 7, 11 and 12.
Emotional bias for 1, 2 and 7.

Emotional bias against 4, 8 and 9.
Retentive bias for 5, 11 and 12.
Retentive bias against 3, 6 and 10.

EXPERIMENT 53. See Alexander's *Intelligence—Concrete and Abstract* for a description of materials, procedure and norms. Of course the norms are for the British Isles.

EXPERIMENT 54. See Ballard's *Group Tests of Intelligence* for a description of the tests, procedure and norms.

EXPERIMENT 55. The American Army Beta test given in Ballard or the group test of the National Institute of Industrial Psychology, London, may be used.

EXPERIMENT 56. The Rice-Binet Hindustani scale has been standardized on Punjab children and Kamat's Scale (Marathi and Kannada versions published by Oxford University Press) on South Bombay State children.

EXPERIMENT 57. Krishnan's Questionnaire has been standardized on Mysore students.

EXPERIMENT 59. Krishnan and Krishna Janamejai have standardized a Neurotic Questionnaire on Mysore students.

Appendix C

List of Apparatus Necessary for Starting a Psychology Laboratory

1. Galton's Normal Probability Curve Board	1
2. *Psycho-Physical Methods:*	
Colour mixers (electric) with colour discs	2
Weber's Law discs ...	2
Tuning-forks with resonance cases	1 set
Jastrow's weights ...	2
Langfeld and Allport's touch weights	2
3. *Sensation:* (a) *Vision:*	
Visual acuity tests for literates and for illiterates	1 set
Langfeld & Allport's blind spot cards	1 set
Eye observation mirror	1
Eye model	1
Brewster's stereoscopes	4
Titchener's stereograms	2 sets
Ishihara's colour perception test	1
Nagel's colour perception test	1
Titchener's campimeter	1
Wallin's after-image cards	2 sets
Coloured glasses	2 sets
Masson's discs ...	2
Spiral discs	2
Hering's contrast apparatus—discrimination of brightness apparatus	1
(b) *Audition*	
Differential tuning-forks	2 sets
Differential sonometer	1
Hammers	2
Resonators	2 sets
Politzer's acoumeters	2
(c) *Olfaction*	
Zwaardemaker's olfactormeters	2
Franz's olfactory stimuli	1 set
(d) *Gustation*	
Franz's taste stimuli	1 set
(e) *Cutaneous*	
Jastrow's aesthesiometers	2
Sliding calipers	2
Spearman's aesthesiometers	2

Boar's bristles	1 set
Ink pad	1
Rubber stamps	2
Jastrow's weights	1 set
Franz's weights ...	1 set
Titchener's pain & pressure points	2 sets
Balances ...	2
Temperature cylinders ...	1 set

(f) *Kinaesthetic, Static & Visceral senses*

Weighted cubes ...	1 set
Collins and Drever's size-weight test	1 set
Arm board ...	1
McDonald's algometer ...	1
Smedley's hand dynamometers	2
Meuman's time sense apparatus	2

4. *Observation*

Picture postcards	3 sets
Familiar and unfamiliar articles mounted on a board ...	3 sets

5. *Attention*

Tachistoscopes with cards	6
Division of attention apparatus	2
Reversible perspective figures	3 sets
Tapping-boards	4
Chess boards	2

6. *Imagery and Imagination*

Galton's questionnaire	500 forms
Whipple's ink blot cards	2 sets
Letters	
Words	

7. *Memory and Learning*

Wirth's memory apparatus	1
Mirror drawing apparatus	6
Mirror groove apparatus	6
Step maze apparatus	8
Finger maze apparatus ...	4
Induction box to give shock; electrodes	4

8. *Perception and Illusion*

Figure and ground diagrams ...	2 sets
Muller-Lyer—with main line alterable	2 sets
Muller-Lyer—with terminal lines alterable ...	2 sets
Horizontal-vertical illusion ...	2 sets
Phi-phenomenon boxes ...	2

Slides showing optical illusions ...	2 sets
Induction coil box for illusion of warmth	1

9. *Suggestion*

Progressive weights	4 sets
Size-weights	4 sets

10. *Measurement of Intelligence*

Verbal tests: analogies, opposites, etc. ...	200 sets
Non-verbal tests	200 sets
Performance tests: Alexander's pass-along test	4
Koh's block design test	4
Cube construction test ...	4
Pitch discrimination	2
Link's form board ...	6
Combination form board	6
Goddard's form board	4
Articles for Binet Simon tests	2 sets
Gessel's infant intelligence tests and apparatus	2 sets
Collin's and Drever's performance scale tests	2 sets

11. *Reasoning*

Syllogisms list to study the effect of prejudice	200 forms
Ruger's wire puzzles ...	2 sets
Valentine's concept formation test	2 sets

12. *Emotions*

Facial expression cards	2 sets
Plethysmograph	1
Psycho-galvanic reflex apparatus	1
Cardio pneumo-polygraph	1

13. *Aesthetic Apparatus*

Colour-preference wheels ...	6
Cards to study the effect of background	6 sets
Pictures ...	1 set

14. *Study of Action*

Reaction apparatus for simple and choice reaction with an electric chronoscope ...	2
Winking glasses ...	4
Shock coils to study conditioned reflex ...	2
Mosso's ergograph	1

15. *Mechanical Ability and Manual Dexterity*

Dynamometers ...	2
Steadiness testers ...	4
Manual dexterity boxes	4
McDougall's dotting tests	2
Cox mechanical ability tests	2 sets

GENERAL EQUIPMENT

220 volts line with a dozen plugs		
Step-down transformers to 4/12 volts	6	
110 volts transformer	2	
Impulse counters	6	
Kymograph	1	
Physiological models of brain, eye, ear, nervous system, skin, cell divisions		
Gramophone with Seashore's records ...	1	set
A.C. to D.C. converters	1	
Pendulum—chronoscope	1	
Typewriter	1	
Duplicator	1	
Complete set of carpenter's and mechanic's tools		
Iron stands	25	
Clamps	25	
Geometrical instruments ...	2	sets
Electric buzzers ...	6	
Electric bells ...	6	
Electric keys of different types ...	20	
Rheostats ...	6	
Storage batteries ...	3	
Adding and multiplication machine	1	
Stop-clocks ...	4	
Stop-watches	4	
Metronomes ...	4	
Battery charger ...	1	
Colour wheel with colour discs	1	
Tuning-forks	1	set
Epidiascope ...	1	
Cine projector ...	1	
Weighing machine: small ...	1	
big	1	
Lantern slidess to illustrate the various topics ...	1	set
Revolving chair	1	

Paper material (300–1,000 copies of each)

Jung's free association list
Controlled association lists—various types of association
Introversion—extroversion tests
Ascendence—submission tests
Value tests
Interest tests
Intelligence tests

Galton's imagery questionnaire
Neurotic inventory
Reasoning tests
Achievement tests: reading, spelling, arithmetic, etc.
Literary and scientific aptitude tests
Clerical ability tests

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