Experimental Psychology

Research Methods and Statistics

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Introduction

This book has been written to meet several needs. Firstly there is a need for a book which integrates statistics, research design, experiments and report writing so that none is learned in a vacuum, as commonly is the case, isolated from the others. The aim is to make the student an active learner encouraged to carry out experiments, so experiencing and understanding the design problems and statistical analyses in the practical context where he can see exactly what he is doing and why. The aim is that by the end of the book, the student should be able to evaluate the research of others, to define a problem, formulate a hypothesis about it, design and carry out the experiment, apply the correct statistics, discuss the results and implications, and write it all up in a logical and sensible fashion. The principle is that old pedagogic one of learning by doing.

Secondly, there is a need for an introductory text on statistics, research design and experimental work for the many students who meet psychology and social science for the first time. The initiate in behavioural science needs to gain a conceptual understanding of statistical procedures and design techniques in order to carry out his own investigations and to understand and evaluate constructively the investigations of others. However, experience has shown us that many students (and even some fellow teachers) are somewhat reluctant to study this area as they believe it is difficult and involves mathematics. These opinions create negative attitudes and low expectations of success at the outset. We try to dispel these fears. This text was designed to present material in small steps, each section and each chapter being built on previous sections and chapters. The only maths knowledge required is the basic four rules of arithmetic (i.e. $+$, $-$, $\times$, $\div$), the understanding of what a square root and squaring a number are, and the ability to read tables. By the time the student has read this text he will have had plenty of practice at all this. Even the mathematically inept should be able to understand and even enjoy the material and activities.

Since this book is meant to be a painless and simple introduction to

what is a very complex array of concepts, designs and statistics, the authors have attempted to reduce mathematical notation to a minimum, present examples wherever possible, explain in everyday language and provide questions for self-testing. After working through this book, students should have a basic framework of knowledge in the area of research design and statistics which can be deepened and refined in later courses and by reading more advanced texts.

So the text is addressed to a wide variety of students. Primarily, school psychology students and first year college psychology students who have not tackled psychology at school form the primary targets. However, all social sciences and paramedical students needing an introductory text on this area will find it a boon, particularly if they are working alone, for the book has been deliberately designed for the student working in conditions of minimum class teaching support or in self-remedial tuition. We have deliberately made references back throughout the book to previously presented material since this distributed repetition improves retention, understanding and transfer potential. The text organization demands that students proceed through the book chapter by chapter and not dipping in here and there. It is so structured that as the student masters the material in each chapter he is learning a basis for the understanding of future chapters, with design concepts and statistics introduced in a logical sequence, one by one.

Self Test Questions (STQs) have been placed within the text and at the end of most chapters to enable students to find out for themselves if they are following what has been presented. Such STQs also enable students to revise and/or practice some of the skills they are being taught. The answers to the STQs are either given immediately after the STQ, when the consequent material requires it, or at the end of the book, or found by referring back to previous material.

Science is man's most serious business, because the history of science is a history of the development of man's mind. Despite the struggle that the scientific point of view has had – and in some cases is still having – in becoming accepted, the fact is that science and its methods have become vital to man's existence. There is every indication, moreover, that the scientific method is becoming even more vital as our knowledge accumulates at a faster pace than ever. For this reason, if not for intellectual curiosity alone, any serious student should be well versed in the objective methods of science. This knowledge will not only enable him to understand how scientists help to solve man's problems but will also allow him to appreciate more realistically what science can and cannot do.

A personal note to students from the authors

This book will provide you with an opportunity to become acquainted with the methods of science and, specifically, with the experimental method in social science and psychology. Essentially, the method in all the sciences is the same; only the content varies. At the heart of science is the experiment, and the major aspect of the experiment is control; in fact an experiment can be defined as controlled observation.

When you conduct an experiment it may not come out in the predicted direction; often results will be contrary to those hypothesized. This is to be expected and in no way indicates that your research was poorly done. You should not always expect experiments to work; we do not set out to prove a hypothesis but to test it. However, whether the predictions are confirmed or not, you must always try to account for the results and discuss their implications.

As is usually the case in an introductory course you will run, analyze, and report on a number of experiments involving humans. It should be kept in mind that an experiment is not supposed to be a social event nor is it supposed to be humorous. Experimenters should be neat, courteous, and, above all, serious.

ETHICAL CONSIDERATIONS FOR RESEARCH INVOLVING HUMAN SUBJECTS

Among the points to keep in mind when you are running your experimental subjects are the following: (1) in most cases your subjects are doing you a favour by participating in your experiments; (2) you are temporarily employing the services of your subjects in a situation that is probably foreign to them, and perhaps even threatening; (3) you are acting as a representative of your profession in general, and of your department in particular; and (4) in many cases you will provide the ony contact that many students will ever have with psychology and social science, or at least with experimental psychology.

It is for at least these reasons that you should observe the following principles in all interactions between you and your subjects:

Never cause undue discomfort or inconvenience to your subjects. A comfortable place for subjects to wait for the experiment to begin should be provided and the experimental environment itself should be as comfortable as possible. If the experiment is to be a lengthy one, always inform your subjects of that fact before they agree to participate.

Always assure your subjects that their performance is confidential. Never discuss how your individual subjects performed on different tasks. Such information is easily misinterpreted.

Do not deceive your subjects. Never even imply that your doing something that you are not. Remember that people are often threatened by psychological experiments; they feel that you are trying to tap the dark recesses of their unconscious mind. Because many individuals are apprehensive about psychological experiments, and because they have many misconceptions, you must go out of your way not to perpetuate any myths about your work. For example, if you are asked by a subject at the conclusion of an experiment whether his or her performance indicated that he or she was 'smart', 'crazy', or some such thing, you must make it clear that such information is not provided by your experimentation.

Always be prepared. Never wait until you are running an experiment to attempt to understand it. Always be prepared well in advance of running your first subject. If some aspect of the experiment is not clear, consult your teacher/tutor. Being unprepared creates an uncomfortable situation for both you and your subject. It reduces the probability of your subject signing up for other experiments, and it creates an unfortunate image of you, your department, and the profession.

Always be on time. Since your subject has extended you a courtesy by agreeing to participate in your experiment, you are obliged to be on time. If for some reason you cannot keep your appointment, make arrangements to notify your subject. On the other hand, if your subject is late or misses an appointment, you should try to understand that being in an experiment at that particular time of day is not something that he or she is used to. Giving subjects some form of appointment card as a reminder should be helpful.

Where possible, inform your subjects about the experiment. Often students will sign up for experiments because they are curious. They want to know what experiments are like and how they would do in them. Their curiosity is often even more intense after they have participated in an experiment, so it is always a good idea to inform students of what was being attempted by each experiment and what was found. But information should not be given until the experiment has been completed by all subjects. One way to do this might be to prepare multiple copies of a brief statement and distribute them to anyone interested. Another way, of course, is merely to post such a statement in a place where those interested can read it.

Be courteous. Common courtesies, such as thanking your subjects for participating, will increase the probability that your subjects will sign up for other experiments. Courtesy also creates a favourable impres-

sion of you and your experimental work. In thanking them you are emphasising the value they have been for your experiment and your success on the course.

Finally may we wish you good luck with your studies and hope you find the contents of this text as valuable and interesting as we have tried to make them.

Many individuals both at student and professional level have contributed to the viewpoints and thinking which characterize this text. To these we owe a debt of gratitude. We are particularly indebted to Mrs G. Claridge, our typist, who produced such a splendid manuscript out of our semi-legible handwriting. Finally, to our close families who bore with us patiently during the long periods of concentration we had to devote selfishly to the production of this book, we are profoundly grateful for their support.

R.B.B.
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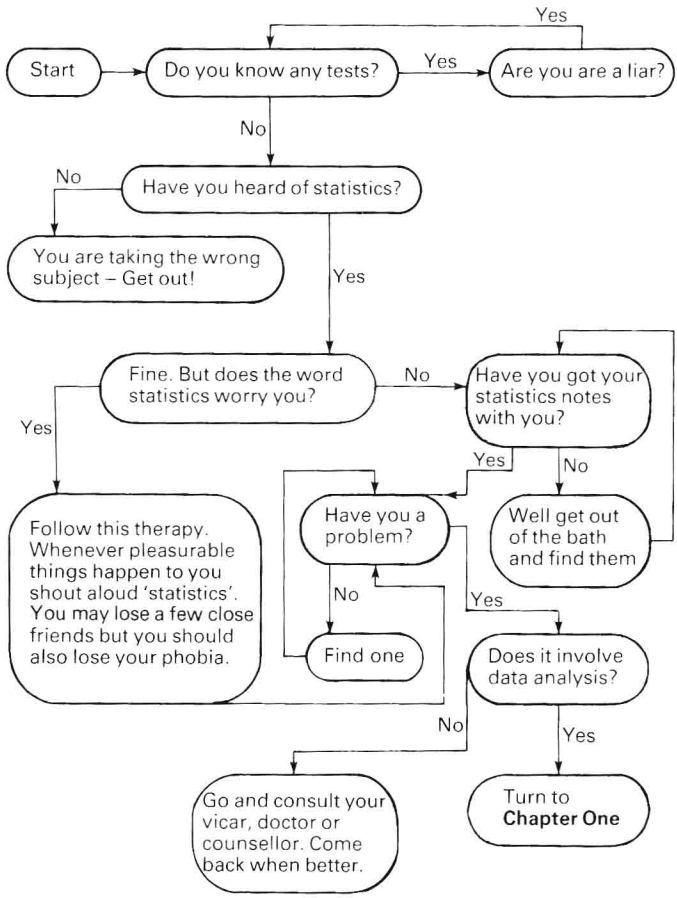
Bradford 1980


Start
Do you know any tests?
Yes
Are you are a liar?
Yes
No
Have you heard of statistics?
No
You are taking the wrong subject – Get out!
Yes
Fine. But does the word statistics worry you?
No
Have you got your statistics notes with you?
Yes
Yes
No
Follow this therapy. Whenever pleasurable things happen to you shout aloud 'statistics'. You may lose a few close friends but you should also lose your phobia.
Have you a problem?
Well get out of the bath and find them
No
Yes
Find one
Does it involve data analysis?
No
Yes
Go and consult your vicar, doctor or counsellor. Come back when better.
Turn to **Chapter One**

Contents

1

Psychology and the scientific method

Introduction

When asked our occupations and we reply that we are psychologists, the frequent response is 'That's interesting, I am a bit of a psychologist myself!' This is a little chastening to our professional pride yet there is an element of truth in the response. George Kelly (1955) echoed the same sentiments when he wrote about his model man – man the scientist, who is continually construing and evaluating his environment to make sense of it. The aspirations of the scientist are in fact the aspirations of all men. In order to live in society, to cope with the mundane aspects of everyday living, each person in his own way must try to understand human experience and behaviour, interpreting feedback from the environment so that he can respond realistically and appropriately, predicting and controlling the course of events in which he is involved. So not only do psychologists, or even teachers, nurses and door-to-door salesmen use psychological knowledge in their daily lives but so does everyone else in their interpersonal relationships. This has caused many people to view psychology as 'common sense messed around a bit' or as an 'abstruse way of stating the obvious'.

However, as in the understanding of most things, understanding human behaviour needs to be effected through as systematic and objective a way as possible, for layman's intuition, subjective judgment and common sense provides in most cases information and theories which are neither 'common' in that it is generally agreed, nor 'sense' in that it is rational. Many of our everyday observations and opinions are distorted in the very act of being made, through subjective bias and prejudice. We stereotype others on scanty evidence, and generalize conclusions well beyond any valid range of generalization. Human beings function on a folklore of unjustified assumptions about behaviour, and woolly armchair philosophizing.

Each day we overhear people making unjustified assertions on often important issues, such as

'Boys are better than girls at maths'

'The Welsh are more musical than the English'

'I am as good a driver when I've had 6 pints as when I'm sober'

'Permissive parents produce children who end up in court'

and so on. Additionally we are confronted daily with claims by so-called experts that have consequences in daily living. Those who can evaluate such claims are better able to separate good solutions from current fads. Newspaper articles and radio broadcasts raise questions about, and discuss such topics as anxiety in children, child-rearing practices, violence on TV, drug addiction, punishment, propaganda, conformity, intelligence, social class and so on. Most of it is generally uncritical, subjective assertions. But in order to understand these topics and find real and valid evidence only a scientific approach to generating and testing ideas will suffice. Too often decisions are made by parents, schools, civil servants, local and central government on important social issues on the basis of expediency, preconception, ideology and bias and not on the basis of the true facts. An understanding of research methods and statistics allows us to evaluate their claims, impressions, ideas and theories and see their implications. Psychologists are interested in all these questions, but the difference between the layman and the psychologist is that the latter employs objective, scientific, controlled experimentation with statistical analysis of data in order to discern what actually is the case, rather than a patchwork of likes and dislikes, rules of thumb, analogy and prejudice.

STQ *Write down in your notebook a couple of sentences explaining why psychology adopts a scientific approach to the study of human behaviour.*

Methods of knowing, or daddy told me

There are four general ways of knowing.

(a) Method of tenacity. Here one holds to the truth because one knows it to be true. The more frequent the repetition of the 'truth' the more the enhancement of the validity of it. It is self-evident then and men will cling to such beliefs even in the face of contrary evidence, e.g. 'The world is flat', 'All Communists are spies'.

(b) Method of authority. A thing must be true if it is in the Bible, or the Prime Minister says it, or teacher said so. The method of

authority is not always unsound but we never know when it is or isn't. But we lack individual resources to investigate everything so the presumed competence of authority offers advantages.

(c) Method of intuition (*a priori* method). This claims that reason is the criterion of truth. It 'stands to reason' that learning difficult subjects must build moral character. But whose reason is to carry the judgment, if two eminent persons using rational processes reach different conclusions?

(d) Method of science. This method has one characteristic none of the other methods has, that is, self-correction. The checks verify and control the scientist's activities and conclusions. Even if a hypothesis seems to have support, the scientist will also test alternative hypotheses. Knowledge is attained through the scientific process because science ultimately appeals to evidence; hypotheses are subjected to empirical test. None of the other methods above provides any procedure for establishing the superiority of one belief over another.

What is science?

When many laymen are asked 'What is science?' they usually define science in terms of one of the physical or life sciences such as biology, physics or chemistry. Seldom is psychology identified as a science. When these individuals are told that psychology is indeed a science, they generally express bewilderment or disbelief. Why is psychology not generally associated with the scientific endeavour? If persons who do not associate science with psychology are asked to explain why chemistry is scientific but psychology is not, they will generally make some reference to facts, theories, or laboratory experiments conducted in chemistry – without realizing that psychology involves all of these factors.

Many individuals state that psychological investigations are not scientific. They seem to believe that the approach used in psychology is radically different and that the subject matter does not lend itself to scientific investigation. One possible reason for this belief is that our culture has promoted a number of false stereotypes about what is scientific. Three popular stereotypes have contributed to the pervasive misunderstanding surrounding scientific activity. The first stereotype is the 'white-coat – stethoscope – laboratory' view of the scientist. This stereotype depicts an individual working in a laboratory in which he or she is conducting experiments to generate facts that ultimately will improve mankind. Television commercials frequently use this

stereotype to lend credibility to their statements about products. An individual wearing a white laboratory coat and giving the appearance of a scientist states that product X, a hair shampoo, has been shown to be superior to product Y – another hair shampoo.

The second stereotype is the scientist as the 'ivory tower', the brilliant person. Scientists are seen as rather impractical individuals who are concerned with complex theory generation rather than the solution of practical problems confronting mankind. They are perceived as persons in their own little world 'doing their own thing'. Frequently, the scientist working in an academic setting is perceived as conforming to this stereotype.

The third stereotype equates scientific endeavours with technological advances. People marvel at the ability to send a man to the moon, to design complex computers or to produce new power sources. They comment on the tremendous advancement in science that has allowed us to accomplish such feats. In this role the scientist is perceived as a highly skilled engineer striving to improve society.

So what is science?

So far we have looked at what science is *not* rather than what it is. Science has at various times been equated with 'a body of knowledge' : but it is not just knowledge replenishing and correcting itself. It is therefore a process or method for generating a body of knowledge. Science, therefore, represents a *logic of inquiry,* or a specific method to be followed in solving problems and thus acquiring a body of knowledge. Knowledge is not distinct from science – rather, it is the product of science. All knowledge, however, is not scientific knowledge. Knowledge acquired through the scientific method is the only type that is *scientific knowledge.*

The scientific method represents the fundamental logic of inquiry, and technique refers to the specific manner in which one implements the scientific method. To state that psychology uses a different scientific method is inaccurate. However, to state that psychology uses different techniques in applying the basic scientific method is accurate. Variation in technique as a function of subject matter can be illustrated by contrasting the various fields of inquiry as well as by contrasting the techniques used in the various areas of psychology. Consider, for example, the different observational techniques used by the astronomer, the biologist, and the psychologist doing research on small groups. The astronomer uses a telescope and, more recently, interplanetary probes in his or her investigations, whereas the biologist uses the microscope and the small-group researcher may use a one-

way mirror to observe subjects' interactions unobtrusively. The scientists in these various fields are all using the same scientific method, the key aspect being controlled inquiry, but the techniques they must use in implementing this method differ. Even within the field of psychology, techniques differ depending on the problem and the subjects, from questionnaires in social psychology to reinforcement in learning theory, and stimulation electrodes in rats' brain in physiological psychology.

Characteristics of the scientific approach

Science has been defined as a specific method of logic of inquiry. This definition suggests that the method of science is somehow unique and different from other methods of inquiry or that it has specific rules or characteristics that have to be followed. Indeed the scientific method does have specific characteristics. These characteristics, while necessary to distinguish science, are not limited to the realm of science. Each of the characteristics could also exist outside of science; however, science could not exist without these characteristics. The three most important characteristics of science are control, operational definition, and replication.

CONTROL

Control is perhaps the single most important element in the scientific methodology, because it enables the scientist to identify the causes of his observations. Experiments are conducted in an attempt to answer certain questions. They represent attempts to identify why something happens, what causes some event, or under what conditions does an event occur. Control is necessary in order to provide unambiguous answers to such questions. Look at this example of how control is necessary in answering a practical question.

> A farmer with both hounds and chickens might find that at least one of his four dogs is sucking eggs. If it were impractical to keep his dogs locked away from the chicken house permanently, he would want to find the culprit so that it could be sold to a friend who had no chickens, or to an enemy who does. The experiment could be run in just two nights by locking up one pair of hounds the first night and observing whether eggs were broken, if so, one additional dog would be locked up the second night, and the results observed. If none were broken, the two dogs originally released would be locked up with one of the others, and the results observed. Whatever the outcome, the guilty dog would be isolated. A careful farmer would, of course, check negative results by giving the guilty party a positive