Readings in
Experimental Psychology

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READINGS IN

EXPERIMENTAL PSYCHOLOGY

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FOREWORD

A. P. Weiss

THE terms *science* and *scientific* to be met frequently in the readings to follow demand an elementary treatment at the outset. Primitive man met with primary difficulty in proposing explanations of natural events. Since no *social* reactions had been developed to pestilence, storm, and famine, he reacted to them in the same way that he would react to a powerful *personal* enemy, by prostrating himself and begging for his life. Consistent with this reaction, primitive man actually invented demons and evil spirits with exaggerated human qualities who were supposed to control the storms or epidemics. This invention further intensified the cowering attitude until it became the only acceptable mode of response to natural situations.

Preventive measures were designed to propitiate the spirit and because he was conceived to have human attributes, presents and sacrifices were given and made in exactly the same way one would try to bribe an unconquerable personal enemy. Since these bribes, or offerings, did not always allay the visitation, and because some individuals seemed to be more successful in their supplications than others, a primitive priestcraft arose, whose specific occupation was to study the storm or pestilence in order to find out more about the likes and dislikes of the spirit, and to devise new sacrifices in keeping with his tastes.

From among these medicine-men and priests there occasionally arose an individual who became so interested in the *search* that he forgot he was searching for a supernatural individual. His observations were restricted to the relationships between the parts of the storm, such as direction of wind, time of year, and temperature. These occasional individuals were the first scientists.

In early times their observations were largely confined to astronomical events. They probably saw spirits in the stars as the names of constellations today witness—but what matter. The spirits were too far away to be immediately dangerous. And study soon showed that, far from being ordered about by the whims of fickle spirits, the astronomic phenomena were a regular progression of events.

Starting with astronomy, the sciences have been developed. Because of the fact of dreams and the very complex social interactions which favor mystical interpretations, the science of human behavior was one of the last to develop. One still hears objections to the scientific study of human behavior because it is robbed of something intangible by that study. Human prejudice in this last, as in all other fields of endeavor, has favored the mystical or supernatural interpretation. Particularly is the scientific study of infants and children looked upon with disfavor. The mother concerned about the height and weight of her child in comparison with other children is annoyed if a psychologist proposes to compare the behavior of her child with others.

In this outline of the development of science certain scientific *criteria* may be discerned. They have been stated before[1] with more or less disagreement between the lists. In the following list there is no attempt at an exhaustive treatment, the mere essentials being presented as the author sees them:

1. The essence of science is *search.* No science can remain static. A *search* for new materials must forever be under way. A scientist may be distinguished from a teacher of science by ascertaining whether or not he is still searching in order that he may add to the accumulated facts of his science.

2. These facts, so collected, must be classified according to their relationship with the accumulated facts. The facts themselves are not static. They are a more or less general agreement that a certain thing shall be considered true. A few hundred years ago it was a fact that the earth was flat because every one reacted as though it were. That is to say, such activities as farming, traveling, and even the limited astronomy of those days could be prosecuted on the assumption of the earth's being flat. No one had ever reached the rim of the earth. No one had circumnavigated the globe. Today it is a fact that the earth is a sphere because authoritative persons react as though it is.

3. A study of these facts and their relations permits the drawing of certain *generalizations* about or from them. The older and more substantiated generalizations are known as *laws.* These laws are not to be considered fixed. They may change with the facts, with new facts, or with more extended generalizations from the old.

4. A *generalization* that extends beyond the accumulated facts at

[1] Most recently by C. M. Jackson, *Sigma Xi Quarterly*, 1930, v. 18, pp. 77-86.

any time is known as an *hypothesis*, and as such is subject to verification and acceptance, or invalidation and rejection upon the accumulation of more data.

5. Scientific search is often aided by *measurement* because by measurement one can describe more accurately than he can by the use of ordinary language. Measurement itself is not science, but is a very useful tool of science. Although the measurements should be as precise as the facts warrant, mere precision does not make science. The technic of measurement has given rise to a "language of science," or mathematics, whose symbolic operations have extended greatly the knowledge in the so-called exact sciences and more recently has been applied to the biological sciences. But a criterion that would exclude from scientists Leeuwenhoek, Darwin, Pasteur, Ross, and Walter Reed, all of whom made little or no use of measurement, is no adequate criterion.

6. Another procedure which has been particularly responsible for the progress of modern science is the *experiment*. Observation of natural events is necessary but too slow. One of the functions of the experiment is to speed up natural processes. Chemists have supplied us with abundant examples of processes which under ordinary conditions require years for their completion, but under the experiment require a much shorter time. Another function is to control. The scientist, of necessity, must simplify the conditions he finds in nature. One way he can simplify is to keep all conditions as constant as he may, except one which is varied systematically, during which time observations are made on the phenomenon in question. But the experiment is not *necessary* to science. A criterion which would exclude astronomy from the sciences is hardly adequate. There can be no manipulation of celestial bodies. And, again, the investigation by Darwin leading to the evolutionary hypothesis was conducted entirely without recourse to the experiment.

Thus we see that a simple definition of what is science and what is not is not possible. We can only examine a specific contribution in terms of the six criteria mentioned above. The more of the criteria which are satisfied, the more likely a given contribution is scientific.

PREFACE

THIS compilation of experiments in modern psychology fulfills two needs of the elementary student. In the first place, it introduces him to experiments which are treated sketchily and at second hand in the formal text. This in itself is no innovation. Instructors have been in the habit of assigning reports to students to make up for the inadequacies of a textbook as an introduction to modern experimental psychology. But besides being a time-consuming method, more seriously, it is often reported that the student who makes the report is the only one who derives any benefit from it. Others, unable to study drawings, tables, graphs, photographs and the other details of the experiment in the short time allotted for the presentation in class, find themselves lost upon trying to reproduce or to assimilate the reported material.

Occasionally it happens that a serious student calls at the library for a copy of the material which has been reported in class in order that he may read it for himself. In a large department it is almost impossible to make articles in original journals available to any considerable number of students. This source-book is designed to remedy this situation by placing a copy of the material in an abridged form in the hands of every student.

The second need concerns courses in which laboratory is offered. For most students the collection of data presents no problem, but the analysis and presentation of it in acceptable fashion is a serious stumbling block. In practically all of the experiments included in this compilation an effort has been made to present "problem," "data," "discussion," and "results" in an acceptable report style. Thus, they are to serve as models in the preparation of an original report from data collected by the student in the laboratory.

Almost without exception the papers included in this collection have been shortened considerably. Enough of each one has been retained to give the student some notion of the mechanics of research without going into the infinite detail and painstaking description necessary in a technical paper. Some of the more remote generalizations, and the less direct allusions have been omitted. In most cases simple language has been substituted for complex statements.

All papers have been compared again with the original after rewriting so that as they now stand they present fairly the generalizations that the original author draws from his own raw data. In the interest of appearance and ease in reading, omissions, insertions or other deviations from the original text are not indicated. Most of the cuts have been redrawn. Where the original cuts are used, acknowledgment is made in the proper place.

As a pedagogical device many identical graphs and tables are presented, i.e., from data exhibited in a table a graph is drawn. The pedagogical value of the device need not be emphasized. As a further aid in the teaching of this compilation, the editor has included introductions to the various readings or sections as they seemed necessary. For the same reason, questions and references are appended to each selection. It will be observed that the questions and the introductory and explanatory remarks are more detailed at the beginning of the book than at the end. There was a definite purpose in the reduction of the commentary. It appears that although crutches are needed when the student is still fundamentally a beginner, the sooner these helps and aids can be withdrawn and the more nearly like an original paper this presentation becomes, the more nearly we are approaching an ideal situation where a careful reading of the paper will provoke questions, criticism and discussion with a minimum of direction from the instructor.

To aid the instructor, page references to standard texts are appended to each section. Since a diversity of texts is now available, it is hopeless to try to arrange the material here in conformity to all of them. Since each Reading is complete in itself, they may be assigned in any order.

Although the original purpose was to include as a single reading only a single experimental paper, the difficulty of this procedure in the two fields of audition and vision is immediately apparent. The work in these two fields has become so refined that a single paper does not cover either adequately. Dr. Beasley has attempted the difficult task of combining several experimental papers into a comprehensive treatment of the simpler experiments in these fields. His task was perhaps the most difficult in the preparation of this volume as even a casual reader in these fields might suppose.

To those others who have contributed special readings, Dr. H. M. Johnson, Dr. Dael Wolfle, and Dr. Helen Morrill Wolfle, the editor is heavily indebted.

To those of my colleagues who have used the volume in two previous mimeographed editions, I want to thank especially Dr. F. C. Dockeray, Harold Gaskill, Dorothy Rose Disher and Theodore Forbes for helpful suggestions derived from their experience.

It is a pleasure to acknowledge my debt to the authors, editors, and publishers whose hearty coöperation expedited the preparation of this book. In each instance the specific acknowledgments are made in the text.

In conclusion let me urge that this compilation is not intended to be a collection of classic experiments. It is rather a comprehensive survey of the contributions from modern laboratories which can be adapted to elementary instruction. Its purpose is to make generally available a sample of the contemporary work of a live and tremendously interesting science. If it in some small measure helps the instructor to keep his discussion on practical issues and free from academic formalism, it will have served its purpose well.

W. L. V.

Columbus, Ohio
May 29, 1931

CONTENTS

IV. INTERNAL STIMULI AND THEIR RESPONSES

V. EMOTION

VI. POSTURAL RESPONSES

IX. LEARNING (B)

X. LANGUAGE

XI. SOCIAL STUDIES

I.

REACTION TIME

I. REACTION TIME

INTRODUCTION

One of the most interesting aspects of the stimulus-response mechanism lies in the fact that there is a rather definite time interval between the time when the stimulus is given and the response ensues. In the laboratory situation the apparatus is arranged so that the instant the stimulus is given, some time-measuring device is started automatically. The stimulus may be a flash of light, a sound, a touch, a shock, a word or any other conceivable stimulating condition, the only requirement being that it must be of sufficiently great intensity that the subject does not have to strain too hard to receive it; for example, if a light, it must be placed so that the subject's eyes may converge on it readily. If a sound, one must remember that comparatively sound travels very slowly and that the air waves comprising the stimulus must get to the ear before the subject can begin to react, so that the sounder must be placed close to the subject's ear. It must also be concealed for if there are any moving parts and they are within the subject's regard, they will be the stimuli for *visual* reactions, when we really want to measure the reaction time to sound.

The reaction of the subject is determined according to some set formula. In what is known as simple reaction time it is generally a movement of the index finger. Sometimes a subject is required to hold a key down and to release it momentarily after the stimulus is given. The time required for these two responses is slightly different. Another requirement for all reaction-time experiments concerns what is known as the "ready signal." Before each stimulus is given the subject must be made aware of the fact. The experimenter generally merely says "Ready." He must be careful, however, to vary the interval between the ready signal and the stimulus or the subject will be using the signal itself as a stimulus and reacting to the interval.

To the beginner this simple group of requirements may seem complicated and unnecessarily detailed, but when one considers the enormous complexity of the reacting mechanism, it is at once apparent that however precise we make the conditions of the experiment, still myriads of other factors over which we have no control are operating to make some times excessively long and others exceedingly short.

The instrument used to measure the time is called a *chronoscope*. It is merely a clock designed to measure time in thousandths of a second. An ordinary clock may operate from either a spring or a weight. Both of these principles have been used in one type of chronoscope known as the Hipp. The pendulum principle has been used in the Seashore, Bergstrom, and Sanford chronoscopes. All of these methods have been superseded in the past few years by the synchronous motor principle which is embodied in the Dunlap chronoscope. This principle has been commercialized recently in the various types of electric clocks now available. Without entering into a technical discussion of the relative merits of the various instruments, suffice it to say that when one starts to break a second up into a thousand units,

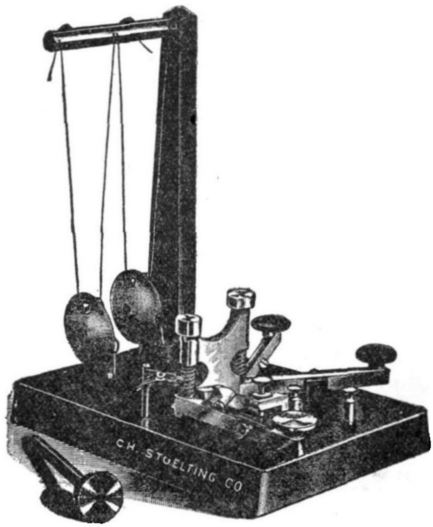

Figure 1.
Sanford's Vernier Chronoscope.
(Courtesy of C. H. Stoelting Co.)

each equal to every other one, he is confronted with difficulties which the builder or user of the ordinary clock does not encounter. In view of these considerations, it is not unreasonable to suppose that a part of the variation encountered in reaction-time measurements is due to the instrument employed in making the measurements, thus relieving the subject of a portion of his responsibility.

Helmholtz believed that, assuming an accurate chronoscope, the variability was due to differences in the rate of conduction of the nervous impulse. Cattell and Dolley (1894) have shown, however, that either hand will react