PSYCHOLOGY BY EXPERIMENT

KLINE

PSYCHOLOGY BY EXPERIMENT

BY

LINUS WARD KLINE, PH.D.

PROFESSOR OF PSYCHOLOGY AND HISTORY OF SCIENCE
SKIDMORE COLLEGE

AND

FRANCES LITTLETON KLINE, B.S.

INSTRUCTOR IN PSYCHOLOGY AND PHYSICS
SKIDMORE COLLEGE

GINN AND COMPANY

BOSTON • NEW YORK • CHICAGO • LONDON
ATLANTA • DALLAS • COLUMBUS • SAN FRANCISCO

PRINTED IN THE UNITED STATES OF AMERICA

627.6

The Athenæum Press
GINN AND COMPANY PRO
PRIETORS BOSTON U S A

PREFACE

This text is written with the conviction that psychology can best be approached under experimental conditions afforded by a laboratory equipped and set apart for such purposes. This position should hardly need emphasis, and will readily be admitted by all psychologists, yet there are very few such introductory laboratory courses. It appears, however, that psychology has made notable achievements and has justified its right to be classed as a science only as it has adopted the methods and procedure of the experimental sciences. It would seem, then, that the methods and technique used in discovering the laws of psychology should, when properly adapted, be most serviceable for teaching them. Moreover, psychology now has its own methods, technique, and apparatus, which have become so manifold, so simplified, and so standardized that it has for some time been possible to assemble, organize, and adapt a course of elementary experiments adequate for an introductory study of mind.

The present laboratory manual has been planned and arranged with the belief that while students are learning the fundamental laws of the science they should have ample opportunity to observe the continuity in its development, that such a course is not only logical and practicable, but is as necessary to understanding the science as are similar courses in chemistry, biology, and physics in their respective fields. It is based upon many years of experience, in which we have carefully tried out the experiments given. Naturally not all the experiments given here could be used in a circumscribed introductory course, but the number has purposely been made large so that selection may be possible.

The student is directed and encouraged to refer to the sources and to check his own work with the results of the pioneers and founders of the science. To this end we have freely drawn from

many sources, to which due reference is made in every instance. The carefully prepared texts and papers of E. B. Titchener have frequently served as models. The pioneer work of the late Edmund C. Sanford pointed the way in preparing laboratory exercises in sensation and perception. In common with present students of mind we are immeasurably indebted to the earliest teacher of one of us, William James. In this group of scientists whose teachings and writings have very materially aided us we desire to include Professor Knight Dunlap.

We are very grateful to Professor Donald A. Laird for reading the first draft of the manuscript and for making fruitful suggestions, to President Henry T. Moore for his advice and helpful comments upon several chapters, and to the authors here named for kindly permission to quote from their writings and to adapt certain of their experiments: Max F. Meyer, W. B. Pillsbury, Daniel Starch, E. L. Thorndike, E. B. Titchener, Lightner Witmer, and Margaret Floy Washburn. To our publishers, Ginn and Company, we are greatly indebted for suggestions adding to the usefulness of the book as a laboratory manual. The publishers who have kindly granted us permission to use quotations or modify and adapt certain experiments to harmonize with the plan of the text are R. G. Adams & Company, The Century Company, Harcourt, Brace and Company, Harper & Brothers, Houghton Mifflin Company, Henry Holt and Company, Alfred A. Knopf, Inc., The Macmillan Company, The C. V. Mosby Company, Psychological Review Company, Warwick and York, Inc., University Tutorial Press, Ltd., and The Williams and Wilkins Company. In each of such cases credit is given in the body of the text or in a footnote.

It is a pleasure to acknowledge the service and coöperation of Elizabeth A. Moshier, Department of Fine Arts, Skidmore College, and of H. B. Settle, photographer, in preparing most of the figures and also of C. H. Stoelting Company for permission to use photographs of their instruments.

LINUS W. KLINE
FRANCES LITTLETON KLINE

SKIDMORE COLLEGE

CONTENTS

ILLUSTRATIONS AND DIAGRAMS

PSYCHOLOGY BY EXPERIMENT

CHAPTER I

INTRODUCTION

The student of a science should become familiar at the outset with the assumptions, general premises, and types of reasoning involved in its investigations and in the formulation of its laws and principles. Such considerations need be neither pretentious nor complex, but should be sufficient to make clear the foundations, the scope, and the limitations of the science in question.

The aim of science in general is to discover and classify facts—facts about objects, facts about processes, facts about relations, and facts about conditions — in order to detect their sequence and causal connections. This aim rests on the assumption that nature is uniform in her operations, meaning by this that from a given set of conditions a predictable group of facts will occur. The key, then, to the facts of a science is to be found in the interplay between the phenomena, or the objects or the forces being studied, and the governing conditions. The conditions may be wholly or partly controlled or, in a few sciences like astronomy and meteorology, entirely uncontrolled. Wherever the conditions are wholly or partly controllable, it is possible to produce the same facts or occurrences at pleasure, thereby contributing immensely to the development of the sciences and facilitating the teaching art.

It is generally agreed that experimentation consists in the operations involved in controlling the conditions and in the observations made on the interaction between conditions and the processes or things being investigated. Such experimentation is usually first encountered in the laboratories of chemistry, physics, and biology. A simple example of the sort may be

seen in the botanist's control of conditions so as to bring out in bold relief the responses of roots and stems of developing seedlings to the stimulus of gravity. He does this by placing the roots of the seedlings in a constantly changing position, so that the stimulating influence of gravity is neutralized and does not act for a long enough time in one direction upon the sense organ in the root tip to accumulate a sufficient amount of excitation from the stimulus. The seedlings are pinned in various positions upon an upright, slowly revolving wheel and kept moist by dripping water. Under these conditions the roots and stems will continue to elongate in the same direction in which they are placed. Such an experiment shows the direct relation between the control of conditions and the sequence of facts essential to an explanation of the behavior of roots and stems under the influence of gravity. Knowing the invariable behavior of roots and stems under given conditions, the botanist expresses the fact in a general statement, or law, which forms the ultimate object of his quest. The fact that the conditions of an experiment may be controlled and varied furnishes a means by which a law may be confirmed, modified, or completely refuted.

The facts of psychology rest upon the same universal assumptions as those of the other sciences with respect to the uniformity and regularity of nature, and as a consequence the psychologist makes the special deduction that uniform psychophysical behavior occurs under similar conditions. The purpose of a psychological experiment is to devise and to control the conditions governing psychophysical responses and from the nature and relationships perceived in the latter to infer the laws of human behavior. Such is even the empirical practice of everyday life: one predicts the usual responses to the bite of a mosquito, to a clap of thunder, to a hearty laugh. In fact, the possibility of the science of psychology rests on the assumption that human behavior is explainable, controllable, and predictable.

It is highly desirable that the student early become imbued with the ideal that he is in search of laws of human behavior and that these laws, when arranged in proper order, in their totality constitute the science of psychology.

Human behavior involves four interrelated factors: (1) conditions including stimuli, (2) mechanisms and powers, (3) responses, and (4) results, or effects. *Conditions* (the word is used here generically) include all those of a specific character, as physical surroundings, social relations, problems (conceived as difficulties, obstacles, and tasks to be changed into simpler terms and forms for thinking about or acting upon), and also *stimuli*, as ether vibrations, radiant energy, and chemical substances. *Mechanisms* and *powers* are the means for making responses and include sense organs and nervous, muscular, glandular, and vascular tissues organized into functional structures operating as related parts of a psychophysical individual. *Responses* consist of the changes and actions, overt and implicit, set up in the organism by either stimulus, conditions, or problems, or any two or all three combined acting upon the individual. The *results*, or *effects*, of a psychophysical response are of two types: (1) effects produced in the individual by virtue of the response; (2) those produced on objects and processes. Upon the first type depend all habit formation, all feeling, all learning and knowledge, and upon the second all art, industry, and the like. This text seeks to emphasize each of the four factors in due proportion, ranking the second — mechanisms and powers — as the chief object of psychology, and the third — responses — as a revelation of the second. Of course the anatomy and physiology of man as related to psychology receive no formal consideration here. The student is referred to standard works on physiological psychology for such study.

Conditions and stimuli are considered only as far as they aid in the explanation of the responses and their effects. But it must be observed that there are many conditions to which man responds that are not as yet amenable to experimental procedure of an exact sort. The conditions provoking complex social processes, graver emotions, and strong passions must still be studied under chance conditions. Here the student of human behavior meets one of the limitations of the science and must perforce rely on fortuitous observations and upon analogies furnished by the study of lower animals.

Perhaps no part of a student's formal school work makes a more direct and persistent challenge to his mental integrity, his industry and habits of work, his nobility of purpose and sense of honor than the requirements inherent in laboratory conditions and methods of learning. But these very conditions and methods may produce malingering responses. Self-deception, easy satisfaction, and loose thinking may develop. Not only to avert such pitfalls and initial difficulties but far more to cultivate systematic methods and habits in experimental observation, a detailed account is given below for performing an experiment and for reporting and interpreting the results thereof.

THE EXPERIMENT

Meaning. In general an experiment is a critical observation made under standard conditions. In particular a psychological experiment consists of critical observations made under standard conditions on the reactions of an individual or of a group to a prearranged set of conditions. The character of the conditions may be of many kinds, and in all cases must be susceptible to control in whole or in part and capable of being repeated; they may be very simple or very complex. And in any and all cases the validity of the results will depend upon a strict adherence to the methods and conditions.

Purpose. The purpose of an experiment, like directions to a place, needs to be understood to perform a guiding function; its title may or may not indicate the purpose, and in the latter case the purpose must be explicitly stated. It is often helpful to re-read the procedure, results, and conclusions of preceding experiments, if related to the problem in question, to clarify the purpose. Before beginning work on an extended experiment, representative texts should be consulted and supplemented by discussion, and in any event an experiment should not be attempted until its object is understood.

Material. A detailed statement of the material should always be given, and if a description of apparatus is necessary, it should be so made as to enable others to perform the experiment with

similar means. If the apparatus is more or less complex, or consists of several pieces, it should be represented by a drawing duly labeled; it should be borne in mind that an unlabeled drawing has no value whatever in scientific work. A verbal description of even a simple apparatus is a valuable exercise.

Procedure. Usually the text will give the essentials of the procedure, but local conditions and other features may necessitate more or less of a departure. The procedure may be of three kinds: In one only the subject's part in the experiment is considered. For example, the subject is alone, without apparatus, and wishes to study the type and content of his memory images; he tries to recall in order the first five presidents of the United States; he observes his efforts to get the imagery, and notes the quality and content of the imagery as it appears. The student is here both subject and experimenter. The second kind of procedure usually requires a description of the apparatus and how to use it. For example, the student wishes to demonstrate for himself the effect that converging the eyes on a near object has on the appearance of a distant one in the same line of sight and records the procedure after this fashion: "I used for an apparatus a pen and a pencil; the former was held about 20 centimeters and the latter 40 centimeters from the eyes. I then looked fixedly at the point of the pen, and while the eyes were thus converged, I could observe out of their corners, as it were, two pencils, etc." A third kind of procedure takes into account a second person, the experimenter. In such cases the record states what the experimenter should do in conducting the experiment, how to use the apparatus, when and how to give signals and make records.

Results. The results of a psychological experiment fall into one of two classes of facts, depending upon whether they are reported by the subject or by the experimenter. Facts observed and reported by the experimenter (E) are termed *experimenter's facts*, or E's report, and those observed and reported by the subject (S) the *subject's facts*, or S's report. A "wry face" made by a subject tasting a bitter substance and observed and

reported by an experimenter illustrates the former type of fact; and the bitter quality of the substance as experienced by the taster is an example of the latter type, and when the fact is thus observed and reported by the subject it becomes available for scientific use.

Obviously experiments made upon animals, children, illiterate folk, and the mentally defective yield facts observed and reported only by an experimenter.

The two orders of facts as they usually occur in laboratory work are here illustrated by a report of an actual experiment. A subject was required to memorize a nine-figure square of Arabic and Roman forms arranged thus on cardboard:

5	L	V
IX	7	II
V	2	VII

The card was exposed to the subject for four seconds, after which he repeated the alphabet for six seconds, and then reproduced as many of the characters as possible. The characters as written are given here and form the experimenter's facts, or E's report, of the results:

9	L	V
X	7	
2	III	

Four were correct, one of which is misplaced, three wrong, and two omitted. The subject at once recorded the facts as observed by him as follows: "The figures were read as separate units and were not combined into a three-place number as 555, top line. The two upper lines were repeated silently (speech motor) and the entire group visualized; repeating the alphabet broke up my speech motor memory; the Arabic figures appeared in auditory imagery, the Roman in visual." Observe how these two groups of facts check and supplement each other: E's report gives both the quality and quantity of the reproduction, showing errors of which the subject was unaware, while S's report presents information of which E's gives no indication whatever.