AN EXPERIMENTAL MANUAL IN PSYCHOLOGY

BY

JOHN FREDERICK DASHIELL

PROFESSOR OF PSYCHOLOGY
THE UNIVERSITY OF NORTH CAROLINA

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PREFACE

PSYCHOLOGY, long considered dependent for her factual material upon the empirical procedures of natural science, is becoming increasingly recognized as a branch of human knowledge that must also be *taught* in a natural science spirit. If students are to have any adequate appreciation of psychological principles, they must have first-hand knowledge of investigative methods, experimental, statistical, and clinical, most especially the first.

For beginning students the experimental courses are in many institutions becoming incorporated with the more theoretical lecture-and-textbook courses; in other places they still have the status of follow-up work with cross-references to theoretical principles presented in the preceding courses.

This manual is primarily designed for the use of the beginning experimental work, on either of these plans. It is the outgrowth of the author's pedagogical experiments extending over some years, in the teaching of an introductory two-semester course. It will be found, however, that the manual is adaptable to the needs of more advanced classes, in which the more elaborate forms of apparatus and more intensive technique are to be recommended.

Many of the experiments ("individual") are arranged for students working in pairs (as experimenter and subject). A few that involve more delicate apparatus or previous experience in technique are planned as group work with an instructor in charge, but with the individual students participating in an active way. Many experiments also are planned for use in those institutions in which at present individual laboratory work is impossible, and the group procedure is to be resorted to perforce. Finally, a few exercises have been included that are not precisely experimental in character but yet are types of work demanded in scientific laboratories; such as the making of drawings, the administration of testing methods, etc.

The MANUAL was originally planned to be used in conjunction with the author's FUNDAMENTALS OF OBJECTIVE PSYCHOLOGY. The experiments parallel throughout the presentation of topics in the FUNDAMENTALS, leaving no important principles in the text without appropriate concrete approach by the student. Thus is avoided the usual disjointed and out-of-step relationship between principle and experiment, with its overemphasis on a few topics and no attention at all to others of recognized importance. The author has sought to provide the student with something concrete and

methodological bearing upon every one, without omission, of those principles in the FUNDAMENTALS that are to be held of first significance.

At the same time, the author believes that the selection of experiments included here makes the MANUAL as useful to teachers employing a wide variety of textbooks as a single manual can be expected to be. He has, therefore, followed the student's instructions for each experiment with suggestive reading references in representative texts.

The convenience of the instructor is held paramount. A considerable number of experiments are included so that he may more readily find those most appropriate to his material facilities, and to his personal lines of emphasis. Alternative procedures and numerous discussion questions are introduced for the same purpose. Explicit directions to the student are furnished, which can be amended and adapted where desired. Bibliographies are omitted (they can be found in the textbooks used), except that the instructor is directed to a few chosen references where he will get definite help in arranging each experiment.

In any scientific field, experiments, like theoretical principles, may become so widely used and universally accepted that an attempt to acknowledge all the sources in every instance would burden the pages and appear pedantic. Where an experiment is included in this MANUAL that is definitely traceable to a certain source or sources, the references and the implied acknowledgments are listed in the appropriate place among the NOTES FOR INSTRUCTORS.

The writer is indebted for advice and assistance in many places to Dr. A. G. Bayroff, Dr. K. L. Barkley, and Mr. H. N. DeWick, past or present instructors in the North Carolina laboratory. In preparation of the manuscript he has had the assistance of Miss Ruth Hamill and Miss Blanche Zorn. Acknowledgment is made to the C. A. Stoelting Company for permission to print illustrations of some of their apparatus, and to Henry Holt and Company for permission to reprint the illustrations from page 76 of EXPERIMENTS IN PSYCHOLOGY, by W. S. Foster and M. A. Tinker.

GENERAL INSTRUCTIONS TO THE STUDENT

THE essence of a scientific experiment on any phenomenon is to control all the conditions (so far as possible), keeping all constant but one; then to vary that one to observe what other phenomena change with it (as cause, or effect, or co-effect). This logic will underly all your experiments. Look for it.

Remember that experimenting on human nature is a more complicated matter than experimenting on frogs or on hydrogen, because a human being is affected by many more kinds of influences, and so the conditions of the phenomenon being studied are much harder to control. Be on the lookout always for factors that may enter in to render your results unreliable — factors of apparatus, of procedure, of personal attitude or condition — and where they cannot be eliminated they should be included in your discussion.

In the individual experiments two students will work together, one acting as the subject (S) on whom the experiment is to be performed, the other acting as the experimenter (E). The procedure is usually repeated after the two have exchanged rôles. Thus, each student will have data on, and is to write up, the other person as his subject. In the group experiments the instructor (I) will usually serve as the principal E, and either all the individual members of the group-as-a-whole or else some selected individual, will act as S. In some group experiments the student will obtain his data at first-hand, in others indirectly from material posted on blackboard or bulletin or else mounted under glass for his inspection and measurement.

To draw a graph: Use cross-ruled paper. Lay out on it the two axes at right angles, a base or horizontal line (abscissa) and a vertical line (ordinate), with their intersection in the lower left-hand corner of the paper. Let distances on the base line represent equal units of the standard or known variable (years of age, number of practice periods, etc.), and distances on the vertical line the found values of the variable you are investigating that correspond to the units on base line (as amount of memory ability at each age given or amount learned at each practice period given). Choose such scales for the axes that the data to be represented will reach from the intersection point almost to the limits of both axes; i.e., cover as nearly as possible the whole sheet. The sheet may be used either horizontally or vertically.

Place scale numbers along both axes, writing them horizontally, and parallel with each axis write the name and units of the variable plotted along this axis. To represent your experimental data locate points at the appropriate distances in the form of large dots, then connect these dots by lines drawn with a ruler. Print neatly the name of the curve (what it shows) in a large unused portion of the sheet. Use ink throughout. There are many curves in the textbooks showing these and other points.

To time short intervals if a stop watch is not available: Use a watch with a second hand. Start the experiment when the second hand is exactly at 60 (noting also the position of minute hand) and at the end of the work note both hands again.

In writing up an experiment follow, as far as possible, the following headings:

PROBLEM: Under this heading state concisely and clearly the nature of the question supposed to be attacked in the experiment. Make clear both the general field of psychology which is involved and the particular points which are specifically attacked.

MATERIALS: Enumerate the pieces of apparatus and other materials used. In some cases a sketch will help. Sketch all electric, pneumatic, or other connections essential to a set-up.

PROCEDURE: Abbreviate the instructions given on these sheets, making your description the simplest possible general statement of what is done. If your actual procedure deviates in any way, describe it as it was *done* by *you*.

RESULTS: Here is required the greatest care. It is absolutely essential that you report exactly what you actually did get, unbiased by what you think you should have gotten. If you wish to discuss the latter do it under DISCUSSION below. Data should be taken down in permanent form and turned in with the formal report. To be scientific, results should be obtained in *quantitative* terms as far as possible. Where tables are used, keep your columns straight by using ruled lines.

DISCUSSION: Give explicit answers to all questions. Be a psychologist here: Make inferences from your experimental work, and especially connect it up with principles found in lectures or text, but beware of mere talk and of too free-and-easy a handling of psychological terms! Feel free to criticize the method or results of the experiment, especially as to sources of error. Don't make this part of the report too mechanical, but think in it.

The ideal of an experimental report is to describe so completely and accurately the experiment performed that any other scientist can know precisely

what was done and what results were obtained, and can, if he desires, *repeat* the experiment for purposes of verification. Follow this ideal.

The student should obtain, in quantities specified by the instructor, the following materials: ruled paper, of composition or note-book type; data sheets, i.e., ruled paper with vertical rulings about 2 cm. for tabulations; coördinate paper, preferably mm. scale; plain bond, for drawings; cardboard for backs; and, if available, title sheets. All sheets should be punched for staples, which are also to be obtained. The data sheets are of great convenience, and should always be brought to any experimental session. If unobtainable [1] in printed form the title sheets should be made out by the student as follows:

University of .....
Psychological Laboratory
Report on
(name of experiment)
.....
Submitted by
.....

Experimenter.....	Subject.....
Date performed.....	Date report due.....
Course.....	Section.....
Time spent in writing.....	Grade.....

Your instructor may ask for "informal" reports on certain experiments. In this case, you will clip out the statements of PROBLEM, MATERIALS, and PROCEDURE given in the MANUAL, paste them into your report with notes on any variations from them you have used, and present your full original data, adding only whatever Discussion is specified by the instructor.

Following the instructions for each experiment will be given a list of reading references to representative textbooks. Full titles for these books are given in the list below; throughout the rest of the MANUAL they will be referred to by the authors' names only:

Breese, B. B., *Psychology* (Scribners).
Dashiell, J. F., *Fundamentals of Objective Psychology* (Houghton Mifflin).
Gates, A. I., *Elementary Psychology*, Revised (Macmillan).
Hunter, W. S., *Human Behavior* (University of Chicago Press).
Perrin, F. A. C., and Klein, D. B., *Psychology* (Holt).
Pillsbury, W. B., *Fundamentals of Psychology*, Revised (Macmillan).

[1] It is best to have a local stationer supply the student with these materials assembled in a large envelope, the title sheets to be printed by him and included.

Robinson, E. S., and Robinson, F. R., *Readings in General Psychology*, 2d edition (University of Chicago Press).

Titchener, E. B., *Text-Book of Psychology* (Macmillan).

Warren, H. C., and Carmichael, L., *Elements of Human Psychology* (Houghton Mifflin).

Watson, J. B., *Psychology from the Standpoint of a Behaviorist*, 2d edition (Lippincott).

Woodworth, R. S., *Psychology*, Revised (Holt).

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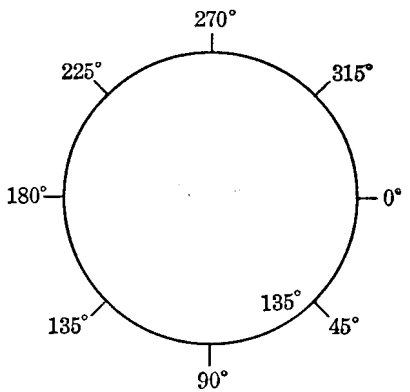
I. LOCALIZATION OF SOUNDS: A SAMPLE PSYCHOLOGICAL EXPERIMENT (INDIVIDUAL OR GROUP)

Problem: To analyze some of the factors that are involved in perceiving the direction of a sound; i.e., in making a correct response to a stimulus-complex of spatial character.

Materials: Sound cage. (Common chair and tin "snapper" may be substituted.)

Procedure: For reading data, draw two large circles on the blackboard with 45-degree divisions indicated and the degrees marked on the outside of the circles. One circle is to be used to record directions in the subject's *sagittal* plane (a plane bisecting the body between the eyes), the other in his *horizontal* plane. Students are to copy the circles.



The figure shows one of the two record circles in which E has recorded the fact that when the sound was produced at a point corresponding to the point marked "45°," S pointed in the direction corresponding to the point marked "135°."

S is to sit with eyes closed and head maintained in a fixed position (by head rest). I or E is to sound sounder once at a point in the imaginary plane bisecting S's body corresponding to one of the points marked on the record circle. S is to judge the direction of the sound by pointing his finger or a pencil, his hand being held close to his chest out of E's way. E is to observe the direction indicated and is to note it in degrees upon the inside of the record circle just opposite the point of *actual* stimulation. (Students to copy.) This is to be repeated for each of the points on the circle, in irregular order, the sounder to be held at a constant distance, about three feet, from the mid-point between the two ears.

Using the horizontal plane (on a level with S's ears), the procedure is to be repeated.

Repeat on two more individuals as S's, to compare results.

A variation in procedure may then be introduced, S cupping his hands to form "ears" turned backward.

Results: Show by reproducing the two circles and the actual and estimated directions.

Discussion:

1. Is localization more accurate in one plane than in the other?
2. Suggest two explanations of this.
3. What would be the result (or results) of producing simultaneously two sounds of identical attributes, one at 40 degrees right, and the other at 40 degrees left on horizontal plane?
4. Is the sound the only stimulus acting upon S, and is his pointing at it the only response being made by him? Be explicit! If there are other stimuli and responses involved in the totality of behavior, how are they "controlled" or checked in this experimental procedure?
5. In S's perceiving the direction of sound is the interpretative process highly conscious, vaguely conscious, or unconscious? i.e., is S clearly, vaguely, or not at all aware of the cues that guide his perceiving?

References: Dashiell, 39–40, 397; Breese, 228–30; Robinson and Robinson, 332–34; Hunter, 266–68; Pillsbury, 326–28.

II. REACTION TIMES (INDIVIDUAL OR GROUP)

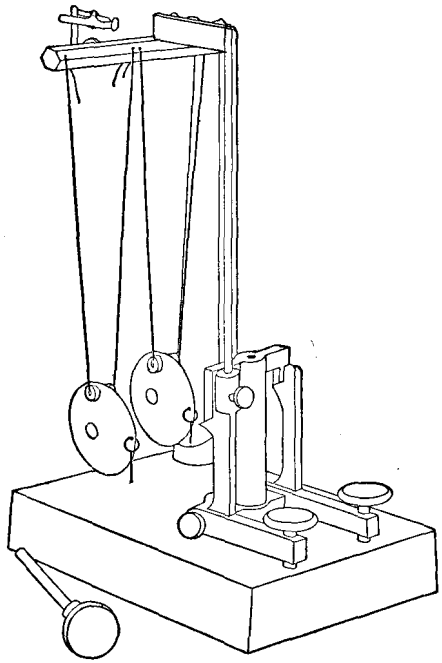
Problem: To study, by the reaction-time method, different degrees of complexity of behavior shown in different types of situation-and-response.

Individual Method

A. The Simple Reaction

Materials: Vernier chronoscope.

Procedure: This experiment tests the time of reaction to a simple visual stimulus. The two pendulum-bobs are to be adjusted until the longer makes 75 complete swings in one minute, the shorter, 77. The wires attached to the pendulum-bobs are then slipped under the metal caps of the proper keys. S is seated in such a way as to face the key which releases the shorter pendulum, with his forefinger resting on the key. E places himself so as to face the key that releases the longer pendulum, his finger on the key. S is to react by pressing his key as soon as he sees E's key move.



When all is ready, E says "Ready," waits between 1 and 2 seconds and presses his key. This releases the longer pendulum. As S reacts, the shorter pendulum is released. E counts the beats of the longer pendulum, calling the first back-swing "one." The counting is continued until the two pendulums come to swing in unison for a brief time. The number of beats until unison is clearly noted (do not judge too quickly!) gives the reaction in fiftieths of a second.[1] Multiply this figure by 20, and the result is in thousandths of a second, or *sigma* (σ). E is not to try to catch S unawares: if he does so, discard the reading. Repeat until 20 reactions are given. S and E then change places.

[1] From the data given it can readily be computed that the longer pendulum makes one complete swing in .8 seconds; the shorter in .7792 seconds. The difference between the two, .0208 seconds, may for this type of measurement be considered one fiftieth of a second.

E and S should make a number of preliminary trials before starting to record any. Occasionally S's will give abnormally short (under 100σ) or abnormally long (over 250σ) reactions; in which cases E should discard them as due to disturbing factors that should have been controlled. The student must beware of anticipatory accessory movements by E that might furnish S with a cue; too constant a fore-period between the warning and the signal; S being distracted by extraneous sights and sounds; and so forth. In these and similar cases the time may well be discarded. In general, this experiment is an excellent one for teaching the student to be on his guard against sources of error.

As the experiment goes on, S should keep in mind the following questions, and E should note any comments on them:

1. In the reaction, was S attending directly to the stimulus (E's key) or to the movement to be made?
2. Was the reaction made deliberately, or did it go off of itself?

Results and Discussion: Set down in your notes the results in the following tabular form. Prepare a table in which successive columns are labeled *Trial, Number of Swings, Sigma,* and *Comments.* In the last column (which should be wider than the others) put down any comments the subject makes. Find and note the average of the times.

B. Choice Reaction

Materials: As in *A*.

Procedure: As in *A*, with the following variations. E holds the forefinger of each hand on the key, which is to be pressed in irregular order with left and with right forefinger. S is to react with his *left* hand when E uses his *left*, likewise for the right hand. Repeat for 20 trials as before, recording but not counting incorrect responses. Then reverse positions.

Results and Discussion: Record the results as before, noting in addition whether E used his right or his left hand on each occasion, and the occurrence of any wrong response. In finding the average, throw out any wrong responses.

1. How do the times compare with those in *A*?
2. In what ways does this experiment differ from *A*?

C. Perceptual Reaction

Materials: Blank showing 100 patches of color each 1 cm. square. (The five sample patches are to be disregarded.) Watch with second hand.

Procedure: E lays the blank before S, showing only the five sample colors at the bottom, which S is asked to name. When this has been done, E is to start S when the second hand is at "60" by exposing the whole blank and saying "Go." S names the colors aloud, reading each line from left to right. The total time is taken. E and S then change places and the experiment is repeated, the blank this time being so placed that the sample line of colors comes at the top.

Results and Discussion: Record the total time, and, by dividing by 100, the average time for each response. Reduce to sigma.

1. How does this average compare with those in *A* and *B*?
2. How does the experiment differ from *A* and *B*?

D. Substitution Reaction

Materials: Blanks showing at the top a key of ten digits and corresponding letters; and showing below rows of digits to which correct letters are to be supplied. Watch with second hand.

Procedure: The printed sheet is to be placed *face down* until the experiment actually begins. E, with the second hand of the watch at "60," gives the signal "Go." S turns over the sheet and with his pencil proceeds to fill in under each digit the correct letter according to the code given at the top of the page. He should work as fast as possible. The total time is taken by E and recorded on the sheet. E and S then change places and repeat, using the other sheet. E should avoid looking at either sheet until he has acted as S.

Results and Discussion: Find the average time for each act of substitution. Reduce to sigma.

1. How does this compare with the times in the other parts of the whole experiment?
2. How does the situation, and how does the response, differ from that in *C*?

General

General Discussion (on whole experiment):

1. Is there a uniform increase in time required for response in the different parts *A* to *D*?
2. Is there an increase in complexity of the stimulus or situation, of the central adjustment, or of the motor response?
3. Carefully describe anything in your procedure or apparatus that might produce errors or inaccuracies in your results.

Group Method

Procedure: Seat the group in continuous rows to form an unbroken chain. I is to apply a stimulus to the first member, his reaction to be a stimulus to the second, and so on down the line. I is to record the total time elapsing between his applying the first stimulus and the reaction of the last individual in the chain (which may be indicated by slapping the hand on a desk, by voice, or other appropriate response).

A. The Simple Reaction

A light tap on the shoulder is used. Upon receiving a tap (stimulus) each individual "passes it on" by giving a tap (his response) to the next individual. Each individual should be turned 90° in his chair, and at I's "ready" signal should have a hand held close to the shoulder of the next person. At least five trials should be taken after at least three practice trials. I notes the total time for the group with a stop watch. The results are to be tabulated on the blackboard under the headings: *Time, Number of Individuals, Time for Average Individual, Same Reduced to Sigma.* A final average of the individual averages is computed.

B. Choice Reaction

Proceed as in *A*, with this variation: each person holds both hands near the shoulders of next person in the chain, and is to react with his *left* hand when he has just been tapped on the *right* shoulder, and vice versa.

C. Free Association Reaction

Vocal stimuli and responses are now to be used. A word spoken aloud by I serves as a stimulus to the first person in the chain, his reaction to be the quick speaking aloud of the first word which comes to his tongue upon hearing I's word. This response serves as a stimulus to the next person, and so on.

D. Judgment Reaction

As a preliminary each person silently says to himself the name of some edible thing. I speaks aloud his word. The first member of the chain *chooses* silently between the edible so named and the one he has named silently to himself, and then speaks *aloud* the name of his *preference.* This is the stimulus to the next person, and so on.

Discussion: All questions for parts *A*, *B*, *C*, *D*, and *General*, as given above.

References: Dashiell, 3–4, 45–48; Titchener, 428–50; Robinson and Robinson, 625–28; Warren and Carmichael, 292–96; Woodworth, 234–36; Gates, 83–85, 87.

III. ATTITUDES IN REACTION TIMES (INDIVIDUAL OR GROUP)

Problem: To measure the part played by the subject's attitude or set in the quickness of his reactions.

Individual Method

Materials: Vernier chronoscope.

A. Length of Fore-Period

Procedure: The method is in general the same as that followed in the preceding experiment on "Reaction Times." S faces the key that operates the shorter pendulum (making 77 swings per sec.), E the one operating the longer (making 75). E gives a warning "Ready" and after a given interval presses his key; and S, as quickly as possible after he sees E's key pressed, is to press his own. E counts the beats of the longer pendulum until it and the shorter one are in unison. This number gives the time elapsing between stimulus and response in fiftieths of a second.

E is now to control the time-interval between his "ready" signal and his stimulus signal (key) by running the following series:

(*A*) 10 reactions in which this fore-period is kept absolutely constant, at 1.0 second.

(*B*) 10 in which this fore-period is varied in irregular order from as short as $\frac{1}{4}$ sec. to as long as 3 or 4 seconds.

(*C*) 10 as in series (*A*).

(*D*) 10 as in series (*B*).

E may follow the above order, *A–B–C–D*, or may follow *B–A–D–C*, without informing S at any time what series is being used.

Results: E keeps a careful record of the series. At the end he averages the time-intervals recorded by the *A* and *C* method and those by the *B* and *D* method.

B. The Three Types of Simple Reaction

Procedure: After a preliminary series of about 5 reactions, secure a total of 60, in this order:

(*A*) 5 'natural'	(*B*) 5 'natural'
10 'sensorial'	10 'sensorial'
10 'muscular'	10 'muscular'
5 'natural'	5 'natural'

To prevent fatigue, rest after each 15, and E and S exchange places after *A* series and after *B* series (each acting as S for the total of 60).