REPRINTED FROM

VOL. II. NO. 1. JANUARY, 1895

THE Psychological Review

EDITED BY

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CONTENTS.

PUBLISHED BI-MONTHLY BY

MACMILLAN AND CO.,

66 FIFTH AVENUE, NEW YORK; AND LONDON.

Single Numbers, 75 cents (3s.) **Annual Subscription, $4.00 (16s. 6d.)**

Berlin, Mayer & Müller (M. 16.50) Markgrafen Str., 51.

Paris, H. Welter (Fr. 21), Rue Bonaparte, 59.

Entered at the Post-office at New York as Second-class Matter.

A LOCATION REACTION APPARATUS.

BY PROFESSOR G. W. FITZ,

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The problem which stimulated to the designing of this apparatus was that of testing the power of an individual to quickly and accurately touch an object suddenly disclosed to him in an unexpected position. In order to make the problem as simple as possible the apparatus (see Figure 1) was so devised that the subject is required to make a movement of the finger from the end of the nose to some portion of the arc of a circle of which he is the centre and whose plane is at the level of his elbow. Three positions were selected to give a wide range of movement, namely, the centre immediately in front and a point on each side at a distance of about 14 in. (A, B and C). The object to be touched consists of a white spot ½ in. in diameter, which may be placed at any one of these points without the knowledge of the subject, a screen being in front, arranged to fall at the proper time and instantly disclose the spot. In connection with this, a pendulum chronoscope is used which measures the interval of time between the falling of the screen and the touching of the white spot.

The apparatus for determining the error is constructed to measure the distance of the centre of the finger (Fig. 2, F) from the centre of the white spot (S) on either side, thus showing the error of the movement executed and its direction. It consists of a horizontal strip (St) of blackened brass 7 in. long, bearing in its centre the white spot (S). This is hinged along one side so that the finger pressure makes an electrical contact (E) to determine the end of the time interval and also releases the clamp controlling the error recording apparatus. Below this are two light arms (GG) pivoted

at a common point directly under the white spot, so that their tips project above the first strip about ¾ in. These arms are connected by a spring (Sp) tending to pull them together, but are held apart in the preliminary position by the

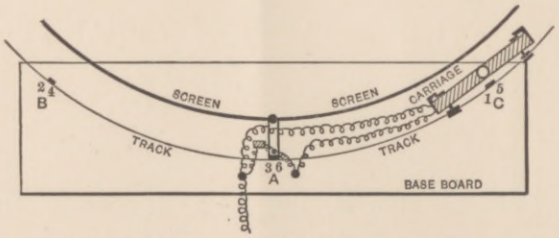

FIG. 1.—LOCATION APPARATUS.

pressure of the clamp projecting downward from strip (St, not shown in diagram) and are released by the touch of the subject, springing instantly to grasp the finger (F) between them. The raising of the finger clamps them anew in this position, and the displacement of the index showing the mid point of the finger can be read on its scale (R–L). This is found to work very quickly and conveniently with practically no observation error. A frame work carries the various parts and a set of wheels enables it to be run into any position desired.

The chronoscope has a balanced pendulum (Fig. 3), 12 inches total length, so weighted (W) that the time of swing is about a second and a half. The pendulum (P) carries a

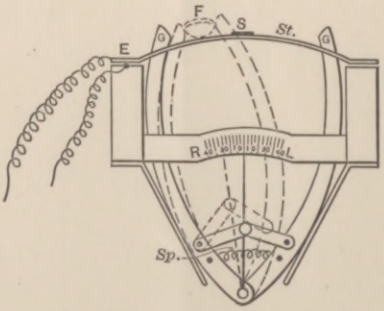

FIG. 2.—ERROR INDEX.

light index (I) that may be clamped instantly in any position on the scale (S), which latter was graduated empirically in hundredths of a second by a falling weight. The pendulum

is held in the preparatory position (Fig. 4) by means of a hook (H) connected with the armature (A) of an electromagnet

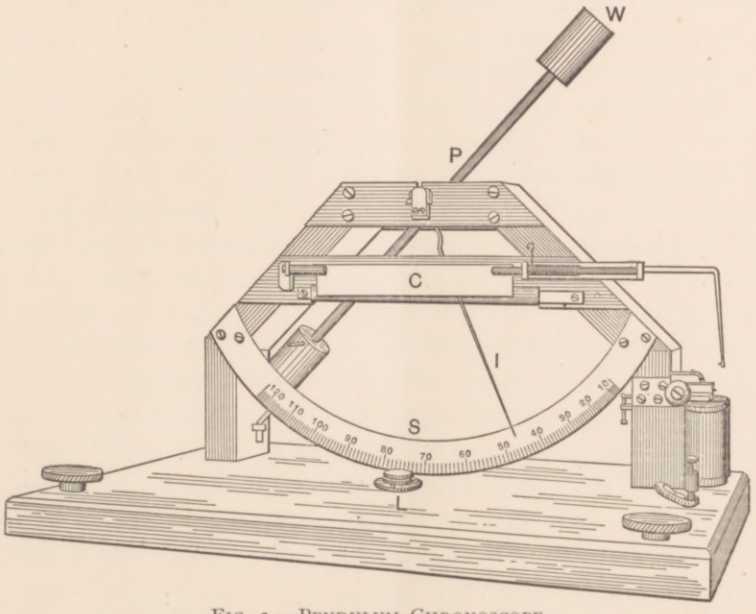

FIG. 3.—PENDULUM CHRONOSCOPE.

M). The breaking of the circuit by the fall of the screen) releases (Fig. 5, R) the pendulum carrying its index; the re-

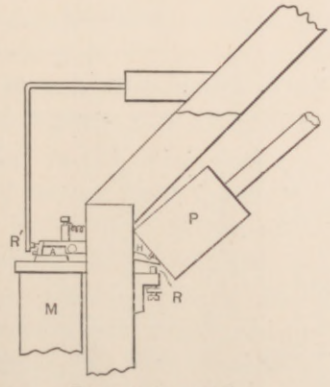

FIG. 4.—PENDULUM AND INDEX CLAMP RELEASE.

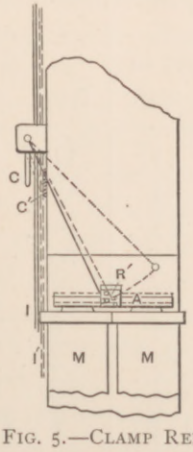

FIG. 5.—CLAMP RELEASE.

making of the circuit, by the touch of the subject's finger, releases (Fig. 5, R) the clamp (C) and catches the index so that

the time may be read upon the scale (Fig. 3, S). There is a level (L) upon the base board to enable one to put it in an exactly horizontal position, and the error of the instrument is thereby reduced to a negligible quantity. The details of the release are shown in Figures 4 and 5.

By means of this apparatus it was hoped to measure some of the elements making up the differences which exist between individuals in their power to do certain things requiring quickness and accuracy, as, for instance, tennis playing and fencing, the essential requirements being the perception and quick interpretation of external conditions, followed instantly by an appropriate motor response. The apparatus gives us somewhat similar conditions to those offered by the games mentioned, but gives them so definitely that it is possible to get a numerical statement of what each individual is able to do in terms of quickness and accuracy. The differences have been found to be remarkably great, and there is an apparent lack of coördination between time and error; that is, those who are quick are not necessarily less accurate than those who are slower.

The accompanying table shows the result of some work with the apparatus, and is given to suggest the wide range of individual ability thus tested.

Time in $\frac{1}{100}$ sec.	Males. No.	Males. % of total.	Males. Av. error.	Females. No.	Females. % of total.	Females. Av. error.
27– 35	11	6.2	11.1	1	1.5	10.
35– 45	48	22.5	10.05	12	18.	9.4
45– 55	54	31.	8.25	18	26.	7.8
55– 65	29	17.	9.	25	35.	7.2
65– 75	18	11.	8.2	11	16.	5.4
75– 85	8	5.	3.1	4	5.	4.4
85– 95	4	2.	4.05	0		
95–105	0	0.	0	1		
105–115	1	.6	7.8			

The tests were made in three positions (A, B, C, in the order 1, 2, 3, 4, 5, 6), as described, every individual making

four attempts in each position, twelve all told. These were recorded separately, hence it is possible to study each effort in relation to the position in which it was made. This was done for both hands to compare the right with the left in regard to quickness, accuracy and direction of error; but it has been thought best not to include a discussion of the results from this standpoint in the present paper.

The table contains a study of the observations made with the right, or preferred, hand by 173 males and 72 females, all those of one individual being treated here as if made in one position. They were obtained from several sources, a large portion of them being derived from the Psychological Laboratory of the Columbian Exposition, Chicago, where the apparatus was in use by Prof. Jastrow, and also from Harvard students and in the Harvard Summer School of Physical Training. Inasmuch as it did not seem possible to make a fair classification of these, they have been arranged in two divisions, male and female, regardless of ages and experiences.

The first column of the table gives the limits of quickness, determining each group of these two classes: the second, in the two divisions of the table, gives the number of individuals whose reactions lie between the limits noted: the third gives the percentage of this number to the total number in the class, while the fourth gives the average error which is a measure of the accuracy of the movements. It will be noticed that the number of individuals of the different groups shows a distinct distribution curve with the apex at about 0.5 Sec. in the males and 0.6 Sec. in the females, suggesting that these are near the means. Of course, this quickness is made up of the reaction—time proper and the time occupied in making the movement from the end of the nose to the plane of the apparatus. It will be noticed also that the average errors for these groups do not vary in ratio to the quickness, but that those who make the movement in .35 Sec. are almost as accurate as the group making the movement in .75 Sec., some being, indeed, more accurate in the former case than in the latter. There is a suggestion of uniformity in the value of the errors, and one cannot help thinking that

the everyday, haphazard activity, demanding as it does a certain degree of accuracy in the execution of movements, determines for each individual his range of error, and that time is the main element of variation.

It will be noted that though the time of the females is longer than that of the males, there is a compensatory increase in accuracy. The relation between time and accuracy has not been determined, so it is not possible to make a statement of the value of accuracy in terms of time, but undoubtedly the individual, who is fairly accurate and very quick, is more accurate when he takes more time, yet it is also true that he is sometimes much more accurate than at others without being necessarily either quicker or slower. These individual variations have still to be studied. The main point to be emphasized now is, that between two persons it is practically possible to bring one element of the test, either time or accuracy, to equality, so that the difference may be expressed numerically in terms of the other. Just what value this series of tests has can not be stated positively, but we believe it has distinct reference to motor ability, and that this will be shown by an increased number of observations upon individuals whose powers are definitely known by comparison with others in the various games.

I wish to acknowledge special indebtedness to Prof. Joseph Jastrow, Mr. G. W. Morehouse, Dr. F. B. Jewett and Mr. A. W. Jeardeau for assistance in getting observations.