ACQUISITION OF SKILL

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

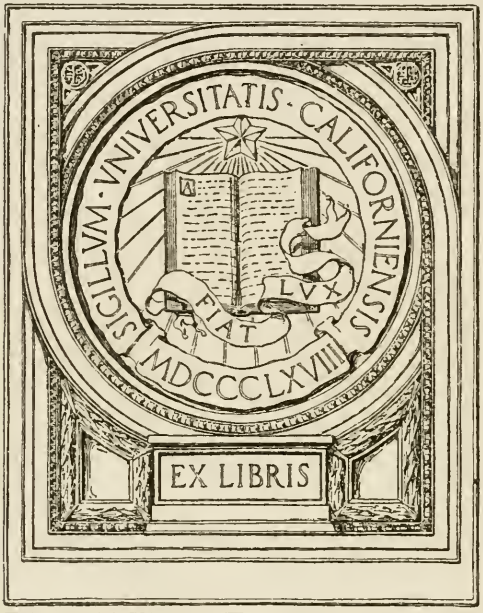
IN THE

UNIVERSITY OF MICHIGAN

BY

WILLIAM HOWARD BATSON

Published as No. 91 of the Psychological Monographs.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INTRODUCTION

Review of Literature

The acquisition of skill in any line of endeavor presents many interesting and important problems. In recent years several studies have been made to determine the factors that influence learning in various fields.

One of the first experiments carefully worked out upon this subject was the study of learning of telegraphy by Bryan and Harter.[1] Their work was based upon the information gained by questioning about two hundred operators, upon reports from schools of telegraphy, and upon the records of individuals that were studying the subject. Two of these individuals were tested weekly from the time they began to practice until they had attained a fair degree of ability as operators. With a third person, the tests commenced about six weeks after he had begun the practice. He was tested weekly on his ability to receive, first, letters not making words; second, letters making words but the words not making sentences; third, letters making words and the words making sentences.

The curves for the first two subjects were plotted by letting the divisions on the y-axis represent the number of letters per minute sent or received and the divisions on the x-axis represent the periods between the tests. The curves for the last subject were three in number. The divisions on the y-axis for each of these represented the number of letters received per minute and the divisions on the x-axis represented the practice periods. The first of these was the letter curve, the second the word curve, and the third the connected discourse curve.

As a result of the information gained from those acquainted with the work and the tests made by the experimenters, they concluded that the curves which represent the sending and re-

[1] Bryan, W. L. and Harter, N. "Studies in the Physiology and Psychology of the Telegraphic Language." Psy. Rev., vol. 4, pp. 27-53 and vol. 6, pp. 345-375.

ceiving ability take different forms. The sending curves rise rapidly for some time and then gradually approach parallelism with the x-axis. The ordinary receiving curve takes a more irregular form and shows at least two extended flat places where there appears to be little or no progress. This was not true, however, in the letter and word receiving curves. Each of these had the same general form as the sending curve.

The reasons given for the difference in the two kinds of curves are the seeming complexity of the language, the difference of opportunity for practice, the pleasure involved, and the intensity of the effort. Bryan and Harter believe that the receiving of the message constitutes a very much more complex act than the sending of a message. The learner is able to make progress more rapidly in controlling a series of quick movements which constitute the sending than in distinguishing the sounds that represent the dots and dashes and the back click of the instrument in receiving.

Besides this, the opportunity for practice in receiving at a slow rate is much less than that for sending at a slow rate. There is no reason given as to why it should be more pleasant to send than to receive. The intensity of the effort is considered to be very important. In this connection, they make the following statement: "One conclusion seems to stand out from all these facts more clearly than any thing else, namely, that in learning to interpret the telegraphic language it is intense effort that educates."[2]

They take the sending curve to be the typical practice curve, and their principal task is to explain the form of the receiving curve. The first ascent appears because the learning of the letters is comparatively easy. The periods of arrest or plateaus in the curve are explained on the basis of different order of habits. "A plateau in the curve means that the lower-order habits are approaching their maximum development but are not yet sufficiently automatic to leave the attention free to attack the higher-order habits."[3] By the lower-order habits are meant those con-

[2] Bryan and Harter. Psy. Rev. vol. 4, p. 50.
[3] *Ibid.*, vol. 6, p. 357.

cerned with the interpretation of letters, syllables, and words. The higher-order habits constitute a system of habits associated with groups of words as they are found in connected discourse. The plateau is a period when no progress is being made in the letter and word habits. They are simply becoming automatic. As soon as they are sufficiently brought under control so that attention is free, the higher connected discourse habits begin to grow and this marks the rise from the plateau.

The attention at first is confined almost entirely to the letters, then to words, and finally to larger sense groups or to the message as a whole. However, the writers do not hold that there is complete isolation of the lower and higher habits. "The synchronous curves of Fig. 30 and the experience of operators agree in showing that from an early period letter, word, and higher habits make gains (a) simultaneously, but (b) not equally."[4] The chief gains, however, are in the lower-order habits. In the sending curve the various order habits are formed simultaneously and so no plateaus appear. Objective and subjective factors have a great influence on the beginner but do not disturb the expert.

Swift studied types of learning of different degrees of complexity and reached conclusions somewhat at variance with those given above.[5] For the purpose of studying the improvement in what he took to be the simplest type of learning, he had six subjects toss balls. Five of these subjects practiced with two balls, receiving and throwing one while the other was in the air. The other subject practiced with three balls, using both hands and keeping one ball always in the air. The balls that he used were of solid rubber, weighing 122.6 and 130.2 grams and being 42 and 44 mm. in diameter respectively. The practice consisted of ten trials daily. The number of throws the subject could make without missing one of the balls constituted a trial. The score for the day was the sum of the catches that were made in the ten trials.

[4] Bryan and Harter. Psy. Rev. vol. 6, p. 350.

[5] Swift, E. J. "Studies in the Psychology and Physiology of Learning." Amer. Jour. of Psy. vol. 14, pp. 201-251.

He found that various objective and subjective factors had a very marked effect upon the learning. The physical efficiency was very important but the subject could not always tell in advance how well he would succeed. He agrees with Bryan and Harter that all advance requires effort but further states that excessive effort may cause the subject to lose rather than gain ability.

The curves for this work were plotted by taking the divisions on the y-axis to represent the number of catches for each daily practice and the divisions on the x-axis to represent the practice periods. All of the curves for this work have the same general form and are concave to the y-axis. All of the curves show great irregularity of advance. In these curves there are no long period fluctuations, as was noted above. There were, however, several short periods during which there was little or no advance.

No immediate rapid rise appears in these curves as appeared in those for telegraphy obtained by Bryan and Harter. Swift thinks that this first rapid rise will appear only in those cases where symbols or other devices are used for handling and presenting ideas. He seems to imply that the curve that is concave to the y-axis is the normal practice curve.[6]

Swift seems to think that the shorter plateaus that he found in this work may be caused by a combination of different factors or by a number of factors that act separately. He is not clear as to whether there is no progress or whether the progress is such that it can not be measured. He says: "This lack of energy, due to waning interest, probably has more to do with delaying the learner's progress and making plateaus than any thing else. One cannot escape a dead level in uninteresting work and after the enthusiasm that novelty stirs has spent itself the interest is dulled and effort slackens. Yet the slow progress is often only an apparent one and due to our inability to measure the advance."[7] In support of this last view, he points out that during the slow period the subjects occasionally made high scores and that at the end of the plateau there was a rise much above the

[6] Swift. Amer. Jour. of Psy. v. 14, p. 228.
[7] Swift. Amer. Jour. of Psy. vol. 14, p. 213.

level immediately preceding the plateau. In another place, he points out that the delay may be the result of having reached the limit of a certain method.[8]

In order to get a curve for a more mental type of work and one that would serve as a comparison curve with those obtained by Bryan and Harter for telegraphy, Swift studied the learning of shorthand.[9] He acted as subject himself and was the only one tested. In this work, an hour and a half a day was given to study for a period of something over ten weeks. During the early part of this time the practice was confined to writing the material in shorthand, but later the daily periods were divided between writing and reading what had been written. He was given a ten minute test daily by an assistant. In both the reading and writing tests the number of words read or written formed the basis for the score. The material for the reading tests was the matter that he had written ten days before.

The curve was plotted by letting the divisions on the y-axis represent the number of words and the divisions on the x-axis represent the practice periods. Swift decided in this work that there was no evidence of higher-order habits being separated from the lower-order habits. There were no long period plateaus. Whatever arrests there were, could be accounted for on the ground of emotional factors.

In explaining the short period plateaus, he uses the following language: "In learning shorthand and presumably also in learning to receive or send telegraphy, a large number of associations are formed that do not affect the speed of the work, because there is no opportunity to use them, and the learner seems to make little or no progress, not because this is the particular time for the formation of a 'hierarchy of habits', for this is going on all the time, but because the range of associated knowledge in the subject is too limited to meet the demand."[10] Swift seems to place his explanation more on a quantitative than a qualitative basis. A certain amount of material must be accumulated and properly associated before it becomes effective, and the accumulation of

[8] *Ibid.*, p. 214.
[9] *Ibid.*, p. 224.
[10] Swift Amer. Jour. of Psy. vol. 14, p. 224.

this definite quantity of material explains what takes place during the arrest period.

In his study of typewriting,[11] he practiced one hour per day with the sight method for forty-four practice days. The score was kept by noting the number of words written per hour. The curves for the work were plotted by letting the divisions on the y-axis represent the number of words per hour and the divisions on the x-axis represent the number of practice periods.

Swift and Schuyler[12] later carried on another experiment on typewriting. In this experiment, Schuyler was the subject and practiced thirty minutes daily by the touch system. The work extended over sixty-six practice days. The material copied was at first taken from Grant's typewriting manual, and later lectures and essays were copied. In this work the number of strokes were used as a basis for keeping the score. For a few practice periods the same sentence was repeated for the whole half hour.

In both of these curves the progress was irregular. The change of copy, physical condition, subjective state, and perhaps other factors contributed to this irregularity. There were no long period plateaus as in the curve for telegraphy. Both simple and complex factors reveal themselves to introspection from the beginning of the work. However, the simpler elements are more active in the early period. The shorter plateaus such as are found here have two causes. "Considered from the standpoint of automatization, they are resting places. The learner has overshot his permanent power and must wait until automatization is perfected. They are also due to slump in enthusiasm."[13] The steps of improvement here as in the ball tossing were made unconsciously and then adopted. Swift holds that this unconscious advance is an argument for the idea that the associations are being made automatic during the apparent rest periods. The lapse of attention which accompanies these plateau periods is a result of the accumulation of loosely connected associations.

[11] Swift. "The Acquisition of Skill in Typewriting." Psy. Bul. vol. 1, pp. 295-305.

[12] Swift and Schuyler. "The Learning Process." Psy. Bul. vol. 4, pp. 307-310.

[13] Swift. Psy. Bul. vol. 1, p. 305.

In the study of telegraphy, a Morse instrument was used and James' "Talks to Teachers" furnished the material. The practice consisted of four hours on four successive days given to the study of the alphabet and following this were thirty-nine practice days. Each of these practice periods consisted of a half hour of practice and five minutes test. The curve for this work was of the same general form as for ball-tossing and for typewriting. He holds that the delays are the result of the time it takes the associations to become automatic.[14]

Swift also studied the learning of a language and secured a curve for the improvement. The Russian language was used as the basis for this work because the subject would be least assisted by his past experience. The practice continued from March 30 until June 14, 1905, and consisted of thirty minutes study and fifteen minutes reading each day. The number of words read was made the basis for the score. The curve obtained from this work showed three periods of advance and four plateaus. He holds here that the plateaus do not represent places of no progress but that the progress cannot be measured. The lower-order and the higher-order habits go along together.[15]

Swift has also studied the problem of relearning in ball-tossing and typewriting. In both cases, he finds that during a long rest period there is little, if any, loss of skill and that the subject in a very short time is able to go beyond his best previous record.[16]

Book has made a more elaborate study of learning to typewrite. His aim was to obtain learning curves that might be explained in detail by the aid of introspections *of* the subjects. Eleven subjects took part in the work. Both the sight and touch methods were used. The score was kept in terms of strokes. The curves were plotted by having the divisions on the y-axis represent the number of strokes and the divisions on the x-axis represent the practice periods.

[14] Swift. "Learning to Telegraph." Psy. Bul. vol. 7, pp. 147-153.

[15] Swift. "Beginning a Language; A Contribution to the Psychology of Learning." Studies of Philosophy and Psychology by Former Students of Charles Edward Garman. Pp. 297-313.

[16] Swift. "Memory of a Complex Skillful Act." Amer. Jour. of Psy., vol. 16, pp. 131-133. "Memory of Skillful Movements." Psy. Bul., vol. 3, pp. 185-187. "Relearning a Skillful Act." Psy. Bul., vol. 7, 147-153.

He found that the curves obtained showed three types of fluctuations: the first was the short fluctuation from day to day; then there were slightly longer periods of arrest which he called "breathing places"; lastly, there were long periods during which there was practically no progress at all, which he called plateaus.

The daily fluctuations he explained on the basis of objective and subjective factors. The principal objective factor was the difference in the material to be copied. On the subjective side the amount of re-learning and warming up, fluctuations in attention, and changes in emotional attitude were very important factors in determining the daily fluctuations. Fatigue from general causes was another important element.

The breathing places were largely the result of lapses in spontaneous attention. In some cases strong application of voluntary effort caused them. Sometimes the subject on good days made an unusually high score and for several days it took all his attention to maintain this level. In this case Book's statement that "It takes some time for the new way of writing to become sufficiently automatic to allow part of the attention to forge ahead in quest of more economic methods,"[17] seems almost to agree with the interpretation of Swift who speaks of giving the associations time to become automatized.

Besides these short period arrests, some long period arrests were noted. The curves of two of the subjects, one that had used the sight method and the other the touch method, showed pronounced long period plateaus. Both of these curves extended over long periods of time. Book thinks that these plateaus belong to rather definite levels of attainment. There is no regular order for the development of special habits in typewriting. These long period plateaus "do not represent periods of incubation, where certain elementary habits make substantial gains, preparatory to their organization into higher-order habits, they are: (a) Resting places in the learner's interest and effort; or (b) 'breakdown' stages caused by excessive effort wrongly ap-

[17] Book, W. F. "The Psychology of Skill: with Special Reference to Its Acquisition in Typewriting." University of Montana Publications in Psychology: Bul. No. 53, p. 155.

plied."[18] Here Book disagrees with both Swift, and Bryan and Harter.

The rise from the plateau, instead of being the result of old associations which have become automatic, is the result of renewed effort by means of which new short cuts have been discovered. He holds that in simple forms of work where only one or a few simple associations are to be formed no plateau will appear. Even in cases of complex work, it is possible so to direct and control effort that they will not appear. Some of his subjects were able to do this complicated work in typewriting without the occurrence of any plateau.

In regard to the warming up and re-learning, the evidence is quite conclusive. The records showed that the last half of the practice period in almost every case gave better results than the first half. Besides the daily revival of the associations already learned, there is a process of getting into a certain "set" which he terms a "typewriting psychosis," and as this "set" comes many of the former difficulties disappear.

Book also gave a number of memory tests in this work. He found that after a period of six months from the time of the last regular practice, ten daily tests showed an average slightly lower than the last ten tests of the regular practice. One year later a second series of ten tests showed a gain over the last ten regular practice tests in the number of strokes, but a slightly higher percent of errors. Book feels that the increase in the number of errors for the memory tests shows that more effort was put forth than had been in the regular practice. This, however, does not account for the increase of skill in the second memory test over the first one nor does it fully explain the gain made over the regular practice. The author attributes that gain, "to the disappearance, with the lapse of time, of numerous associations, bad habits of attention, incidentally acquired in the course of learning, interfering habits and tendencies, which, as they faded, left the more firmly established typewriting associations free to act."[19]

[18] Book. "The Psychology of Skill," p. 157.
[19] Book. "The Psychology of Skill," p. 80.

Several less extensive studies have been made touching upon the subject of the acquisition of skill. Among these may be mentioned the work of Scripture, Smith and Brown; Johnson; Partridge; Bair; Wells; Starch; and Whitley.

Scripture, Smith and Brown studied the effect of practice upon one's ability to insert a needle into a small hole. They reached the conclusion that the improvement was due to the training of attention and that it was psychical rather than physical. Any distraction or mental or physical fatigue lowered the result. The best results were obtained when the attention was fixed upon the hole rather than upon the needle.[20]

Johnson had his subjects practice at tapping at the corners of an equilateral triangle. In this work, he found that all of the curves of improvement follow the same form. He reached the conclusion that transition from a state requiring constant attention to a state of automatic control follows a law as exact as any physical law. But because the subjects are never mentally and physically equal at two different tests and because we do not have scientific results from allied subjects, it is difficult to determine the law. The closer the personal factors are to the normal and the more accurate the measurements, the nearer the curve will show the law of habit. The daily variations in the curve can be explained by the variations in the subjects.[21]

Partridge studied the reflex wink. The work consisted of having a little hammer hit a glass plate immediately before the eye. The two adult subjects used were able to improve greatly their ability to inhibit the wink and their curve of improvement shows a steady rise from the beginning with the usual daily fluctuations in the successive tests.[22]

Bair studied the acquisition of control over a voluntary muscle and found that the power was gained by associating the given muscle in a group with others. After the power was gained to

[20] Scripture, E. W., Smith, T. L., and Brown, E. M. "On the Education of Muscular Control and Power." Studies from the Yale Psy. Lab., vol. 2, pp. 114-119.

[21] Johnson, W. S. "Researches in Practice and Habit." Studies from the Yale Psy. Lab., vol. 6, pp. 51-103.

[22] Partridge, G. E. "Experiments upon the Control of the Reflex Wink." Amer. Jour. of Psy., vol. 11, pp. 244-250.

move it with others, the ability to move it separately was obtained by concentrating the attention upon the particular act. He also studied the nature of the improvement of subjects practicing on throwing shot into a tumbler and manipulating a modified form of typewriter. These tests were continued only for a few days and do not give much idea of the curve of improvement.[23]

Wells did some work with special reference to fatigue phenomena but also touching upon the problem of improvement. The unit of measurement used was the taps upon a telegraph key. The subject selected his own method of tapping but did not change it during the experiment. The subject commenced at a given signal and continued at maximum speed for thirty seconds. After a rest of two and one half minutes this was repeated. Five trials of thirty seconds each were given each day. Two of the subjects practiced for thirty days. The work of these two subjects is the only part that is important here.

The curves show a constant improvement until near the end, when progress gradually diminishes. There is no rapid rise at the beginning of the curve. In a later test on one of the subjects there was an improvement over the best score at the end of the practice.

There was evidence of warming up for both subjects, and as the practice continued this warming up process increased. After an intermission there was a loss in the right hand in all cases and a loss in the left hand in the first case but a gain in the second and third for Subject 1. Subject 11 in all three cases with each hand showed a gain. With both subjects, the first interval of five seconds showed a gain but fatigue came in and made the total score lower in the cases stated above. The only explanation he offers for the initial increase is that it is the result of a renewed "Neuigkeitsantrieb" but he seems to think that the practiced co-ordination parts become more firmly set during a period of rest. He further points out that the daily fluctuations in this work vary more after a week than at the beginning.[24]

[23] Bair, J. H. "Development of Voluntary Control." Psy. Rev., vol. 8, pp. 474-510. "The Practice Curve." Mon. Sup. to Psy. Rev. No. 19.

[24] Wells, F. L. "Normal Performance in the Tapping Tests." Amer. Jour. of Psy., vol. 19, pp. 437-483.

Starch studied the trial and error method by having a subject trace a six pointed star as it is seen in a mirror. He finds that the advantages of using a figure in the form of a star rather than some other form are, that it gives frequent changes in direction, the divisions are of equal length, and they are sufficiently long to be difficult and yet not cause undue fatigue. The curves were obtained by taking one hundred records made at the rate of one a day on consecutive days. Both an error and a time curve were plotted.

The error curve falls rapidly at first and then gradually until near the end of the practice where it seems to have reached a dead level. The time curve shows a rapid fall at first but after about fifty practices it remains nearly parallel to the horizontal axis until the error curve ceases to fall then it takes another drop. Near the end of the practice it again approaches parallelism with the x-axis.[25]

Whitley gave a number of tests to determine individual differences. She emphasizes the importance of a number of tests in order to get a true estimate of a person along any line. She also points out the danger of mis-interpreting measurements. She believes that in the same field, improvement follows the same law for different individuals. The higher mental functions are more susceptible to practice than the sensory functions.[26]

A large number of other improvement tests have been made, but, since very little of the motor element was involved, they have little connection with this problem and are not discussed. In all the tests mentioned except the first three the period of practice was rather short and very little can be said about the longer period plateaus. In every case the short fluctuations appeared.

[25] Starch, D. "A Demonstration of the Trial and Error Method of Learning." Psy. Bul., vol. 7, pp. 20–23.

[26] Whitley, M. T. "An Empirical Study of Certain Tests for Individual Differences." Archives of Psychology, No. 19.

Problem Stated

From this work have grown a number of interesting problems and not a few conflicting opinions are held in regard to the questions raised. The influence of the objective and subjective factors on different types of learning and on the same type of learning at different stages of development, the daily fluctuations in the curve, the warming up process, the general form of the curve, the effect of short and long rest periods—all present fields for further study. One of the most troublesome problems is that of the plateaus. Are they the result of different habit levels, are they due to the automatization of associations, are they dependent upon attention, or may there be some other explanation? Are they necessary for all or any types of learning?

The purpose of this study is: first, to get more information in answer to the questions stated above; second, to gain such information on the other points pertaining to the curve of learning as the data will afford.

The plan of the work has been so to devise experiments that the elements determining the curve of learning can be analysed. In the first set of experiments, the factors affect the process of the learning simultaneously. In the second set, the work is reduced to its simplest form and only a relatively simple sensori-motor reaction is required. In the third set, several factors influence the same learning process but they act in succession. On the basis of this work, the curves are plotted and the explanation of their form is given. The study ends with a general discussion of these results in their relation to the results that have been obtained in other experimental work in this field.

THE EFFECT OF A NUMBER OF FACTORS WORKING SIMULTANEOUSLY

Method of Procedure and Results

This part of the work is a continuation of Swift's ball-tossing experiments. The only apparatus used was two hollow rubber balls and two pieces of hard rubber. The balls weighed 16.7 and 17.1 grams and were 1.6 inches in diameter. The pieces of hard rubber were cylindrical in form, weighing 8.91 and 8.94 grams and being .5 inches in diameter and 2.1 inches long. Neither the difference in weight of the pieces of hard rubber nor of the balls could be noticed.

Five subjects took part in the work. Subjects D(Decamp), B(Batson), W(Wang), and F(Foulk) were all graduate students taking research work in Psychology. Subject H(Hayes) was a junior in college taking Psychology.

Experiment I. Subject D.

Subject D. was instructed simply to toss and catch the ball so that one ball would be always in the air. He had had no previous experience. The right hand was used. The practice consisted of ten trials daily at 10 A. M. The work was commenced on October 8, 1912 and continued until November 23, 1912. After the first three days the same room was used for practice. The subject knew his score daily as well as that of each of the other subjects doing the work at that time. There was no limit put upon the time between trials. At first scarcely any time was taken but as the success became greater and the work was more fatiguing a minute or two was taken for rest between successive trials. Table I shows the result of this practice in detail.

TABLE I

Subject—D.
Experiment—Tossing and catching two rubber balls with right hand.

Trials	1	2	3	4	5	6	7	8	9	10	Sum
Oct. 9	1	2	2	2	3	3	3	1	2	2	21
10	2	2	4	7	3	3	7	1	3	6	38
11	3	1	8	3	3	3	1	2	3	2	29
12	2	3	2	3	2	2	5	2	2	3	26
13	2	3	3	11	4	1	3	2	2	5	36
14	7	1	2	9	3	1	2	1	1	4	31
15	5	4	3	4	2	2	2	1	3	3	29
16	3	6	3	3	2	2	3	3	2	2	29
17	24	2	2	4	10	2	5	3	5	3	60
18	6	12	4	4	5	8	3	8	3	3	56
19	10	7	4	10	2	5	1	2	4	1	46
20	18	4	2	3	4	0	3	4	0	8	46
21	2	9	5	1	4	3	3	2	4	11	44
22	5	5	4	3	6	17	3	0	9	2	54
23	13	4	9	5	4	1	2	4	9	3	54
24	4	0	14	7	8	33	0	2	3	14	85
25	22	3	6	0	2	5	3	7	4	5	57
26	6	12	4	5	9	13	11	11	5	6	82
27	9	9	16	22	0	3	7	2	11	3	82
28	10	20	9	7	24	29	22	2	35	26	184
29	10	1	16	35	7	3	1	27	1	4	105
30	23	23	4	31	21	2	28	17	15	5	169
31	17	3	35	40	4	17	18	7	18	37	196
Nov. 1	19	1	1	9	1	8	2	8	32	18	99
2	21	10	40	19	35	40	1	6	12	14	198
3	37	11	34	6	12	32	62	5	56	45	300
4	52	4	20	11	32	58	9	28	2	61	277
5	52	25	47	49	45	5	59	3	45	65	395
6	17	4	67	43	6	6	4	10	29	114	300
7	14	13	32	29	5	34	34	9	1	0	171
8	18	23	22	16	18	10	39	48	96	54	344
9	84	23	4	60	80	22	16	21	7	33	350
10	24	30	6	27	9	33	48	37	5	5	224
11	2	51	25	24	27	67	13	72	16	24	321
12	8	22	38	9	81	27	24	57	28	66	360
13	37	42	64	51	88	8	64	18	60	31	471
14	42	15	21	26	37	64	102	77	30	24	438
15	57	5	39	29	27	23	16	62	76	12	346
16	100	2	32	35	46	3	43	42	17	60	380
17	48	55	27	0	48	10	3	9	30	5	235
18	22	25	101	33	35	65	37	123	17	53	511
19	8	26	88	265	16	95	82	19	32	78	709
20	36	151	20	29	74	79	58	30	48	63	588
21	3	151	259	0	170	58	70	247	181	265	1404
22	116	88	72	94	80	53	179	222	47	124	1075
23	113	30	137	178	65	0	74	352	96	24	1069
Total	1134	943	1357	1261	1169	958	1175	1616	1115	1396	12124

When these trials are divided on the basis of those that fall below twenty, those between twenty and ninety, and those that are ninety or above, the following results are obtained:

	Below 20	20 to 90	90 or more
First third of table	149	1	0
Second third of table	98	52	0
Third third of table	37	99	24

The horizontal columns opposite the dates show how many catches were made each trial. The vertical column to the right marked "Sum" shows the number of catches that were made during the ten trials of each day's practice. The last set of figures at the bottom of each vertical column shows the sum of the columns. This gives the sum of all the first trials, second trials, etc. The number at the base of the column marked Sum shows the total number of catches that the subject made in all the practice that was taken.

The subject was tested again under the same conditions on August 15 and 17, 1913, and the following figures were obtained:

Trials	1	2	3	4	5	6	7	8	9	10	Sum
Aug. 15	85	90	84	108	89	32	97	108	82	107	882
Aug. 17	113	107	243	18	88	78	148	8	148	54	1005

He was tested again July 10, 1914, and made:

Trials	1	2	3	4	5	6	7	8	9	10	Sum
July 10	95	166	297	268	131	253	351	432	75	482	2550

The balls for this test were similar to those used above but weighed 20.3 and 18.1 grams respectively. The test was made in a smaller room but it is not likely that this had any effect upon the throwing. The subject had not practiced from the time the regular practice had ended up to the time of the test of August 15, 1913. Between that time and the test in July 1914, he had occasionally tossed different objects but was sure that all this practice would not amount to a half hour.

Experiment II. Subject B.

In this experiment the work was the same as in the preceding one, that is to toss and catch two balls. The method was to center the attention on some one phase of the work. The subject aimed to fix his attention on the manner of pitching the balls. The balls were pitched in a circle from right to left. Only a very little incidental practice in this work had taken place

before the experiment. The right hand was used. The practice was in the forenoon and consisted of ten trials daily. The work commenced on October 15, 1912 and continued until November 11, 1912. All the practice was in the same room. The daily score was known. As much time was taken between the separate trials as the subject desired. Table IIa shows the result of this work. Table IIa is arranged the same as Table I and the explanation of the first table may be used for this one.

TABLE IIa

Subject—B.
Experiment—Tossing and catching two rubber balls with right hand.

Trials		1	2	3	4	5	6	7	8	9	10	Sum
Oct.	15	7	8	6	6	1	6	4	11	9	17	75
	16	1	10	13	2	2	7	4	4	5	6	54
	17	3	13	7	20	10	23	12	10	10	17	125
	18	12	2	3	1	5	22	22	0	5	3	75
	19	10	27	2	35	1	15	16	8	8	10	132
	20	12	8	9	30	4	11	24	13	31	35	177
	21	6	1	0	32	3	47	24	25	10	28	176
	22	37	7	1	41	35	34	4	23	31	8	221
	23	13	19	23	6	49	18	14	36	28	23	229
	24	1	23	2	41	12	4	38	31	22	29	203
	25	11	7	12	28	6	37	23	35	46	14	219
	26	4	6	28	70	45	16	19	52	17	18	275
	27	11	9	25	35	45	24	53	46	24	40	312
	28	34	77	38	7	0	20	11	79	28	70	364
	29	20	40	24	42	64	15	79	69	90	67	510
	30	98	58	52	142	31	52	33	16	6	8	496
	31	7	72	3	15	31	35	38	35	54	41	331
Nov.	1	29	75	69	21	109	48	112	33	77	66	639
	2	44	165	148	92	19	56	108	40	34	59	765
	3	1	63	110	41	13	11	27	34	31	167	498
	4	3	114	24	11	63	22	117	79	60	13	506
	5	25	20	47	23	29	59	75	100	15	184	577
	6	23	19	104	63	123	118	92	42	73	137	793
	7	183	90	31	110	163	153	111	142	64	74	1120
	8	159	107	112	33	26	58	53	95	18	42	703
	9	31	46	124	131	42	39	65	84	74	245	881
	10	114	67	43	46	262	134	149	96	84	197	1192
	11	29	206	184	65	179	332	14	7	121	134	1271
Total		927	1359	1244	1189	1372	1416	1340	1245	1075	1752	12919

When the trials of Table IIa are divided on the basis of those that fall below twenty, those between twenty and ninety, and those ninety or above, the following results are obtained:

	Below 20	20 to 90	90 or more
First third of table	64	26	0
Second third of table	27	58	5
Third third of table	12	47	41

After the subject had been able to make an average of one hundred catches per trial on successive days with the right hand, the practice was changed to the left hand. The method was to give attention to all the particulars,—the force of the throws, the direction, the manner of catching the ball, the position of the body, etc. There had been no previous practice with the left hand. The practice consisted of ten trials daily in the forenoon. The work commenced November 12, 1912 and continued until January 15, 1913, with an intermission from December 20 to January 8 and one practice period on November 28. A part of the practice was in a smaller room than that in which the work commenced, but the walls were the same in color and the lighting was about the same. The daily score was known. No time limit was set between trials. The result of this practice is shown in Table IIb.

TABLE IIb

Subject—B.
Experiment—Tossing and catching two rubber balls with left hand.

Trials		1	2	3	4	5	6	7	8	9	10	Sum
Nov.	12	2	4	2	4	0	4	2	6	2	5	31
	13	3	2	2	3	7	5	6	3	1	8	40
	14	6	6	7	9	8	8	9	6	8	2	69
	15	21	2	20	3	2	2	2	0	4	10	66
	16	13	13	1	7	10	17	0	1	9	7	78
	17	3	7	6	2	6	2	8	10	6	0	50
	18	6	3	8	21	3	7	4	6	9	4	71
	19	5	17	4	4	7	8	7	9	2	10	73
	20	1	11	17	7	3	4	8	11	9	13	84
	21	9	4	2	12	11	9	0	10	25	10	92
	22	28	12	4	18	7	14	6	14	22	19	144
	23	2	17	14	20	3	19	12	8	11	15	121
	24	3	7	11	4	12	11	6	4	9	11	78
	25	16	8	11	10	16	5	3	11	8	5	93
	26	7	11	7	7	0	2	21	10	19	14	98
	27	3	5	14	28	13	6	1	0	15	0	85
	28											
	29	2	10	6	5	14	21	15	6	23	4	106
	30	6	6	2	21	12	13	20	42	13	14	149
Dec.	1	9	15	28	12	20	22	2	20	8	27	163
	2	22	14	8	12	13	15	1	7	8	13	113
	3	10	23	4	13	16	15	21	20	11	5	138
	4	28	16	6	9	19	20	27	2	26	3	156
	5	15	11	14	12	25	22	10	29	12	24	174
	6	9	31	19	12	23	16	29	5	7	39	190
	7	10	35	10	40	20	20	17	32	6	23	213
	8	22	17	17	28	40	27	17	29	3	14	214
	9	21	50	8	49	5	21	26	41	13	7	241
	10	31	40	35	34	5	24	37	11	26	5	248

TABLE IIb

Subject—B.
Experiment—Tossing and catching two rubber balls with left hand.

Trials		1	2	3	4	5	6	7	8	9	10	Sum
Dec.	11	5	6	35	39	17	30	46	21	11	45	255
	12	26	56	11	4	8	27	24	9	24	52	241
	13	19	71	3	53	63	23	7	21	36	41	337
	14	74	90	34	30	5	7	60	7	1	39	347
	15	60	18	8	32	140	83	29	39	59	83	551
	16	3	5	63	178	80	38	3	104	45	96	615
	17	110	56	69	79	35	64	88	48	45	29	623
	18	38	5	25	50	204	0	43	20	32	42	459
	19	31	34	12	28	75	11	23	101	46	74	435
	20	35	91	0	1	21	22	27	14	35	6	252
Jan.	8	14	153	40	66	85	5	91	45	42	67	608
	9	101	61	16	46	127	108	9	19	23	6	516
	10	58	103	62	31	44	41	10	95	51	16	511
	11	83	37	57	24	9	149	85	31	45	76	596
	12	45	44	118	30	48	12	17	94	11	108	527
	13	118	65	73	30	8	133	60	123	117	119	846
	14	35	130	289	48	166	119	133	162	153	115	1350
	15	42	73	268	241	156	10	161	26	52	141	1170
Total		1210	1495	1470	1416	1611	1241	1233	1332	1143	1466	13617

When these trials of Table IIb are divided on the basis of those that fall below twenty, those between twenty and ninety, and those that are ninety or more, the following results are obtained:

	Below 20	20 to 90	90 or more
First third of table	143	7	0
Second third of table	87	63	0
Third third of table	34	88	38

The subject was tested again on July 17, 1914. The conditions were the same except that the balls were slightly heavier, weighing 20.3 and 18.1 grams respectively. The difference in weight, however, could not be noticed.

With the right hand, the following score was made:

Trials		1	2	3	4	5	6	7	8	9	10	Sum
July	17	329	4	7	142	0	86	100	1	227	228	1124
July	18	63	82	55	201	130	257	169	60	36	384	1437

The left hand was tested on July 17, 1914, and again two days later. The score was:

Trials	1	2	3	4	5	6	7	8	9	10	Sum
July 17	10	17	57	73	14	78	41	98	52	49	492
July 19	23	70	59	52	88	46	68	130	114	52	702

The subject had tossed tennis balls a few times after the regular practice had stopped but not over fifteen minutes had been spent in such work. There had been no practice with the left hand. A rest of two minutes was made between each trial of this last practice.

Experiment III. Subject W.

The subject was instructed to toss and catch the two balls after the same manner as the other subjects. The practice consisted of ten trials daily at eight A. M. The work was commenced Oct. 30, 1912, and continued until Feb. 12, 1913. During this time, the following daily practices were missed: Nov. 3, 5, 6, 21; Dec. 7, 8, 12, and the period from Dec. 20 to Jan. 8. After a few practices, the subject rested one minute between trials. He had had no previous practice in the work. The results of his work are shown in Table III.

TABLE III

Subject—W.
Experiment—Tossing and catching two rubber balls with right hand.

Trials	1	2	3	4	5	6	7	8	9	10	Sum
Oct. 30	1	1	1	4	1	2	3	1	3	3	20
31	2	2	3	3	2	2	3	4	2	2	25
Nov. 1	2	2	2	2	2	3	2	1	1	3	20
2	4	1	3	4	3	1	2	1	3	2	24
3											
4	2	1	2	3	1	2	3	4	1	1	20
5											
6											
7	1	0	2	2	3	3	5	5	4	3	28
8	2	2	3	1	4	5	6	2	7	5	37
9	4	5	2	5	3	6	7	5	5	3	45
10	5	0	5	4	8	3	5	3	6	6	45
11	0	5	7	0	3	3	5	3	2	6	34
12	4	14	2	8	2	2	4	2	5	3	46
13	5	4	3	6	4	3	7	2	1	5	40
14	6	4	7	3	11	2	6	6	2	4	51
15	4	3	4	5	2	4	6	3	6	6	43
16	5	7	18	8	9	3	4	1	8	1	64
17	5	3	7	0	5	8	2	0	5	1	36
Nov. 18	2	4	4	0	8	3	3	1	2	7	34
19	11	0	6	7	2	14	2	9	16	9	76
20	10	6	1	3	2	11	2	9	4	8	56
21											
22	2	3	4	13	1	0	2	7	2	11	45

TABLE III—(*Continued*)

Subject—W.
Experiment—Tossing and catching two rubber balls with right hand.

Trials		1	2	3	4	5	6	7	8	9	10	Sum
	23	3	15	17	4	3	7	5	12	13	2	81
	24	4	2	5	9	8	7	9	12	8	15	79
	25	4	22	7	20	4	13	9	4	8	3	94
	26	3	8	7	20	10	7	4	11	9	3	82
	27	12	8	11	22	7	6	18	1	4	24	113
	28	2	4	8	5	2	6	8	8	4	4	51
	29	11	2	7	1	8	5	1	0	0	7	42
	30	15	15	4	11	26	9	12	4	17	5	118
Dec.	1	5	4	10	9	4	10	8	5	5	2	62
	2	4	10	5	6	9	23	6	17	12	3	95
	3	8	29	21	3	19	16	22	7	11	16	152
	4	11	25	7	7	5	25	7	4	29	10	130
	5	3	15	28	32	17	5	16	24	0	12	152
	6	1	0	7	11	11	52	2	6	12	12	114
	7											
	8											
	9	1	9	2	9	24	24	16	8	19	17	129
	10	29	20	34	10	32	7	10	52	31	5	230
	11	5	17	8	17	21	25	53	6	22	34	208
	12											
	13	7	14	29	9	66	5	7	2	39	0	178
	14	12	23	6	29	35	25	2	6	42	9	189
	15	8	1	11	10	2	28	9	0	12	15	96
	16	23	14	29	13	39	13	40	28	14	0	213
	17	3	12	16	31	35	19	31	36	12	49	244
	18	28	11	19	4	63	10	6	0	24	13	178
	19	33	12	29	81	21	23	26	43	13	62	343
	20	96	52	5	58	7	4	16	55	39	18	350
Jan.	8	12	10	11	25	55	11	17	18	47	32	238
	9	21	8	23	80	19	8	23	44	11	18	255
	10	22	25	8	49	40	8	21	4	15	84	276
	11	10	66	5	12	10	8	17	17	4	0	149
	12	8	35	40	63	3	7	11	8	22	50	247
	13	30	52	56	50	13	62	34	63	0	1	361
	14	32	30	111	39	80	42	13	21	23	28	419
	15	0	59	27	20	55	30	24	13	24	24	276
	16	8	84	36	24	3	16	27	33	32	31	294
	17	10	7	13	87	24	37	24	58	19	68	347
	18	11	24	16	41	12	28	50	23	32	6	243
	19	28	36	26	23	19	39	23	51	40	26	311
	20	26	27	25	46	13	18	45	14	25	10	249
	21	8	32	10	18	56	11	19	32	26	66	278
	22	24	51	55	25	27	10	14	50	16	10	282
	23	3	19	35	50	55	91	20	75	33	42	423
	24	23	79	15	78	60	15	3	13	6	22	314
	25	4	26	22	38	28	24	27	73	30	50	322
	26	3	74	64	32	63	50	39	38	68	17	448
	27	9	41	33	28	62	67	20	43	38	4	342
	28	21	7	8	9	110	74	54	124	9	50	466
	29	61	93	95	60	7	17	36	1	9	18	397
	30	19	10	27	15	53	21	20	15	57	50	287
					Second trial on same day							
	30	27	19	39	23	43	14	49	27	40	30	311
	31	54	69	33	97	29	66	33	25	13	43	462
Feb.	1	32	30	11	2	16	46	28	48	89	37	339
	2	87	36	5	23	68	72	12	20	26	22	371

TABLE III—(*Continued*)

Subject—W.
Experiment—Tossing and catching two rubber balls with right hand.

Trials		1	2	3	4	5	6	7	8	9	10	Sum
Feb.	3	43	51	62	14	8	37	36	25	48	88	412
	4	3	29	89	22	64	105	36	79	90	41	558
	5	19	51	9	32	101	50	29	41	126	27	485
	6	50	9	53	97	54	58	91	133	127	26	698
	7	4	41	43	3	83	11	52	84	79	127	537
	8	26	24	105	37	33	79	81	133	16	48	582
	9	72	136	106	27	186	61	12	52	73	16	741
	10	67	9	106	100	44	71	114	111	70	152	844
	11	19	77	118	160	159	172	88	66	23	117	999
	12	181	110	132	59	72	103	178	116	36	118	1105
Total		1485	1997	2090	2120	2381	2093	1842	2211	1923	2038	20180

When the trials of Table III are divided on the basis of those that fall below twenty, those between twenty and ninety and those ninety or above, the following results are obtained:

	Below 20	20 to 90	90 or more
First third of table	265	5	0
Second third of table	158	110	2
Third third of table	68	176	36

Subject W. was tested again under the same conditions on June 26 and 27, 1913. He had had no practice in the meantime. The results were:

Trials	1	2	3	4	5	6	7	8	9	10	Sum
June 26	2	62	27	68	73	37	167	92	66	116	712
June 27	53	51	173	230	36	170	67	130	181	215	1306

On July 3, 1914, the subject was tested again in the same room and under the same conditions except that the balls weighed 20.3 and 18.1 grams respectively. The scores were:

Trials	1	2	3	4	5	6	7	8	9	10	Sum
July 3	146	55	116	115	105	118	201	205	156	145	1362

The subject had thrown a few times three or four months before with tennis balls but with no intention of making a high score. He had also tested himself once before with these same balls but did not think that over twenty minutes had been spent in such practice.

Experiment IV. Subject F.

Part I

In the first part of this experiment, the subject was to toss and catch the two pieces of hard rubber described above in the same manner as the other subjects caught the balls. No specific directions in regard to the manner of attending the work were

given. The subject had had some little experience in tossing and catching balls. The right hand was used. The practice consisted of ten trials. The work was commenced on Oct. 9, 1912 and continued until Jan. 12, 1913. The practice was on alternate days from Oct. 9 to Nov. 19 and after that it was daily. The following practices were missed: Nov. 24 and from Dec. 20 to Jan. 8. The same room was used for all the work except a few practice periods near the end. The last room was not very different from the former one and no change was noted as a result of this. The subject knew his score. He took as much rest between trials as he desired but it was never over two or three minutes. The results of his work are shown in Table IV which is arranged on the same plan as those for the ball tossing.

TABIE IV

Subject—F.
Experiment—Tossing and catching two pieces of hard rubber.

Trials		1	2	3	4	5	6	7	8	9	10	Sum
Oct.	9	2	7	9	8	12	2	6	9	7	6	68
	11	1	4	6	5	2	8	11	10	9	9	65
	13	3	3	9	19	5	9	7	13	7	3	78
	15	2	2	3	6	10	13	6	4	15	5	66
	17	1	5	8	3	7	26	4	12	13	18	97
	19	17	3	14	14	9	11	7	6	3	32	116
	21	17	2	10	9	4	18	7	6	12	5	90
	23	11	14	0	6	3	8	15	12	11	9	89
	25	33	10	2	13	3	6	4	6	4	10	91
	27	20	3	9	4	22	8	30	9	12	9	126
	29	13	3	0	6	47	12	11	22	2	11	127
	31	25	17	9	10	2	9	3	5	11	11	102
Nov.	2	7	3	9	10	14	2	26	5	3	7	86
	4	3	12	13	35	12	19	6	11	8	3	122
	6	13	11	7	5	21	39	40	12	18	17	183
	8	6	2	11	29	7	5	13	22	0	6	101
	10	17	8	4	16	3	2	15	14	0	9	88
	12	7	24	11	7	10	5	15	20	7	52	158
	14	5	6	9	17	12	57	7	64	6	6	189
	16	24	9	25	15	37	12	1	47	32	56	258
	18	9	13	3	18	14	4	7	39	41	4	152
	19	18	28	21	17	16	53	28	17	12	14	224
	20	5	21	10	7	9	26	39	12	8	4	141
	21	7	15	0	32	5	31	21	20	13	22	166
	22	20	8	53	22	40	11	21	3	35	3	216
	23	14	16	0	12	31	20	19	3	28	11	154
	24											
	25	17	44	5	7	22	12	10	35	2	20	174
	26	7	30	14	25	2	12	37	41	29	9	206
	27	34	7	11	32	18	46	26	9	7	25	215
	28	8	16	30	47	4	19	4	13	8	9	158
	29	41	4	26	22	4	14	2	42	26	7	188
	30	3	0	10	24	5	13	14	0	1	0	70

.. TABLE IV

Subject—F.
Experiment—Tossing and catching two pieces of hard rubber.

Trials		1	2	3	4	5	6	7	8	9	10	Sum
Dec.	1	34	2	13	22	75	32	15	4	8	18	223
	2	24	45	5	11	13	8	12	1	36	78	233
	3	13	3	12	34	14	7	9	13	13	53	171
	4	11	20	0	1	16	12	5	6	3	22	96
	5	19	18	3	28	39	36	3	49	44	9	248
	6	20	34	9	37	52	54	44	46	13	26	335
	7	14	15	5	31	11	30	56	95	3	36	296
	8	10	69	35	40	108	59	121	10	8	104	564
	9	15	103	53	67	85	28	110	25	24	22	532
	10	7	194	193	66	157	128	115	46	53	6	965
	11	121	119	13	133	72	44	103	71	108	57	841
	12	68	34	53	23	141	130	88	146	41	84	808
	13	76	91	91	113	113	122	44	66	32	61	799
	14	36	145	115	12	96	2	38	98	18	64	624
	15	44	165	83	30	110	52	77	24	112	78	775
	16	54	45	19	121	208	71	69	4	179	71	841
	17	66	265	294	195	111	59	30	15	54	197	1286
	18	1	71	102	120	180	11	285	60	77	29	836
	19	91	12	136	16	31	25	159	88	128	33	719
	20	10	115	117	137	76	98	57	5	95	36	746
Jan.	8	20	37	89	60	1	54	24	19	102	80	486
	9	14	60	41	24	99	35	59	117	77	37	563
	10	6	113	72	9	159	23	82	67	35	57	623
	11	4	191	318	187	9	110	19	25	39	165	1067
	12	221	484	20	391	78	123	254	109	159	116	1955
Total		1409	2800	2232	2410	2466	1885	2340	1752	1851	1951	21096

When the trials in Table IV are divided on the basis of those that fall below twenty, those between twenty and ninety, and those ninety or more, the following results are obtained:

	Below 20	20 to 90	90 or more
First third of table	169	21	0
Second third of table	114	76	0
Third third of table	31	90	69

The subject was tested again on June 1, 1913, and made the following score:

Trials		1	2	3	4	5	6	7	8	9	10	Sum
June	1	29	157	158	69	154	110	10	0	54	21	762
June	2	4	97	27	31	19	106	75	67	14	184	624

No practice had been taken between the end of the regular practice and this date.

Experiment IV. Subject F.

Part II

In this part of the experiment the subject was requested to toss and catch two balls, keeping one in the air all the time. The same balls were used that had been used by the other sub-

jects. The practice was with the left hand. The subject had had no previous practice with that hand. In this work, the subject continued each day until he had made one thousand catches. There was a rest of one minute between each hundred catches. The work was commenced on Jan. 13, 1913 and continued daily until Feb. 4, 1913.

The number of misses before a hundred catches were made in each trial and the total number of misses in each day's practice are shown in Table V. Where zero appears in the table, the subject was able to make a score of one hundred without missing. It should be noted that the number of misses counted is always one less than the number of trials for each one hundred catches.

When the columns are added vertically so as to show how many misses were made in catching the first hundreds, second hundreds, etc., the following figures were obtained:

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Sum
44	27	32	37	38	52	36	26	23	35	350

The total number of catches was 23000. This represents the amount of practice the subject had. Table Va shows this work in detail. This table, with the exception of the first day's practice, shows where each miss was made for each one hundred catches.

TABLE V

		1st 100	2nd 100	3rd 100	4th 100	5th 100	6th 100	7th 100	8th 100	9th 100	10th 100	Sum
Jan.	13	4	4	5	8	4	12	8	3	4	4	56
	14	5	5	4	8	9	6	2	2	1	3	45
	15	3	2	1	5	5	7	5	4	1	2	35
	16	2	2	3	3	4	2	4	1	3	4	28
	17	3	3	2	2	5	2	2	1	2	2	24
	18	3	0	3	0	2	1	2	1	0	5	17
	19	2	1	1	0	0	1	1	0	3	3	12
	20	4	0	1	0	1	0	1	1	1	0	9
	21	1	0	2	1	1	1	1	1	0	3	11
	22	2	0	0	1	0	3	2	0	1	1	10
	23	2	3	2	0	2	4	1	3	0	2	19
	24	2	1	2	4	1	4	0	1	2	1	18
	25	2	0	1	0	0	0	0	2	3	1	9
	26	2	1	1	1	0	1	2	0	0	1	9
	27	1	1	1	1	0	3	1	2	1	1	12
	28	0	2	0	1	1	1	1	0	0	0	6
	29	0	0	0	1	0	0	0	0	0	1	2
	30	0	2	1	1	0	2	0	2	1	1	10
	31	1	0	1	0	2	1	0	0	0	0	5
Feb.	1	1	0	0	0	0	0	2	0	0	0	3
	2	0	0	0	0	0	0	1	1	0	0	2
	3	4	0	1	0	1	1	0	1	0	0	8
	4	0	0	0	0	0	0	0	0	0	0	0
Total		44	27	32	37	38	52	36	26	23	35	350

TABLE Va

Subject—F.

Experiment—Tossing and catching two rubber balls with left hand. Each practice was a thousand catches with one minute rest between each hundred. The first horizontal row in each group represents the number of misses in each hundred. The figures just below show the count at which the miss was made. The column at the right shows the misses per one thousand catches.

Trials		1	2	3	4	5	6	7	8	9	10	Total
Jan.	13	4	4	5	8	4	12	8	3	4	4	56
Jan.	14	5	5	4	8	9	6	2	2	1	3	45
		28	20	9	11	16	13	74	64	74	39	
		44	48	66	13	20	36	90	90		46	
		49	76	77	34	28	55				84	
		58	94	81	41	29	58					
		76	97		77	41	69					
					88	49	97					
					94	51						
					100	67						
						87						
Jan.	15	3	2	1	5	5	7	5	4	1	2	35
		8	50	87	24	42	11	31	45	32	29	
		17	91		60	46	21	42	71		98	
		33			66	49	40	90	79			
					92	67	43	92	86			
					100	85	52	96				
							67					
							73					
Jan.	16	2	2	3	3	4	2	4	1	3	4	27
		37	55	48	32	25	26	14	10	25	10	
		55	99	54	61	60	74	32		64	21	
				88	100	71		64		89	48	
						74		81			59	
Jan.	17	3	3	2	2	5	2	2	1	2	2	24
		37	6	34	14	16	44	20	4	56	26	
		66	34	48	35	17	97	75		66	47	
		87	59			26						
						77						
						94						
Jan.	18	3	0	3	0	2	1	2	1	0	5	17
		56		42		75	51	52	69		3	
		68		57		94		61			13	
		81		67							46	
											70	
											86	
Jan.	19	2	1	1	0	0	1	1	0	3	3	12
		39	69	44			42	4		35	2	
		57								86	4	
										88	61	
Jan.	20	4	0	1	0	1	0	1	1	1	0	9
		11		78		98		10	99	66		
		23										
		60										
		70										
Jan.	21	1	0	2	1	1	1	1	1	0	3	11
		35		10	7	34	17	71	90		67	
				79							98	
											99	

TABLE Va (*Continued*)

Subject—F.

Experiment—Tossing and catching two rubber balls with left hand. Each practice was a thousand catches with one minute rest between each hundred. The first horizontal row in each group represents the number of misses in each hundred. The figures just below show the count at which the miss was made. The column at the right shows the misses per one thousand catches.

Jan.	22	2	0	0	1	0	3	2	0	1	1	10
		1			45		24	12		76	26	
		33					41	90				
							67					
Jan.	23	2	3	2	0	2	4	1	3	0	2	19
		80	37	51		46	66	36	38		22	
		96	63	95		86	81		71		91	
			77				87		76			
							98					
Jan.	24	2	1	2	4	1	4	0	1	2	1	18
		18	73	4	33	70	46		94	48	54	
		66		83	58		69			71		
					87		75					
					90		79					
Jan.	25	2	0	1	0	0	0	0	2	3	1	9
		1		92					17	14	88	
		10							91	60		
										91		
Jan.	26	2	1	1	1	0	1	2	0	0	1	9
		9	74	92	75		54	3			73	
		35						66				
Jan.	27	1	1	1	1	0	3	1	2	1	1	12
		3	87	82	63		39	40	42	10	97	
							50		70			
							71					
Jan.	28	0	2	0	1	1	1	1	0	0	0	6
			62		57	4	3	94				
			77									
Jan.	29	0	0	0	1	0	0	0	0	0	1	2
					5						10	
Jan.	30	0	2	1	1	0	2	0	2	1	1	10
			85	54	95		47		32	89	52	
			87				74		70			
Jan.	31	1	0	1	0	2	1	0	0	0	0	5
		79		56		60	50					
						80						
Feb.	1	1	0	0	0	0	0	2	0	0	0	3
		78						82				
								95				
Feb.	2	0	0	0	0	0	0	1	1	0	0	2
								75	1			
Feb.	3	4	0	1	0	1	1	0	1	0	0	8
		2		88		75	84		62			
		26										
		45										
		80										
Feb.	4	0	0	0	0	0	0	0	0	0	0	0

Experiment V. Subject H.

This work was the tossing and catching two balls. No further instructions were given than that the subject should toss and catch one ball while the other was in the air. The practice consisted of five hundred catches, or as near as the score under the conditions could be kept to that number, daily. In the last trial that commenced below the five hundred, the subject was permitted to continue until he missed. This sometimes ran slightly over the five hundred. The practice was taken in the evening between seven and eight o'clock by electric light. The work commenced Feb. 3, 1914 and continued until March 1, 1914. The following days of practice were missed: Feb. 10, 18 and 28. The subject had had no previous experience in tossing balls. A rest period of five minutes was given as near the two hundred and fiftieth catch as it was convenient to make it without stopping the subject in the midst of a trial. The results of this practice are shown in Table VI.

TABLE VI

Subject—H.

Experiment—Tossing and catching two rubber balls with right hand. Each practice was five hundred catches with five minutes rest near the 250th catch. The numbers at which the misses were made are given below.

Feb. 3—1, 2, 3, 5, 7, 9, 10, 13, 15, 18, ——— 22, 26, 29, 30, 32, 34, 37, 40, 44, 46 ——— 49, 51, 55, 56, 57, 57, 61, 62, 63, 64 ——— 67, 70, 73, 75, 78, 79, 80, 84, 85, 88 ——— 93, 95, 100, 102, 102, 103, 105, 111, 112, 116 ——— 123, 125, 129, 133, 135, 139, 140, 148, 149, 153 ——— 160, 163, 166, 171, 173, 176, 179, 182, 184, 186 ——— 188, 193, 195, 198, 201, 203, 205, 208, 212, 215 ——— 219, 221, 223, 224, 227, 231, rest period, 232, 233, 238, 240, 241, 251, 265, 276, 277, 281, 293, 296, 299, 301 ——— 303, 304, 308, 317, 325, 330, 334, 336, 341, 343 ——— 349, 351, 358, 365, 368, 384, 386, 396, 404, 410 ——— 414, 418, 428, 431, 434, 435, 437, 442, 445, 446 ——— 449, 454, 455, 460, 465, 468, 474, 477, 483, 488 ——— 491, 492, 494, 497, 500. Total 145.

Feb. 4—4, 7, 12, 14, 16 ——— 19, 21, 23, 25, 28, 31, 34, 38, 43, 46 ——— 47, 49, 49, 58, 64, 64, 65, 71, 75, 77 ——— 81, 85, 92, 96, 100, 105, 109, 109, 120, 120 ——— 123, 128, 131, 137, 141, 143, 146, 149, 150, 155 ——— 163, 177, 181, 189, 193, 200, 208, 218, 222, 226 ——— 226, 229, 231, 237, 247, rest period, 252, 253, 258, 263, 268 ——— 280, 284, 289, 292, 293, 294, 297, 319, 326, 329 ——— 335, 336, 347, 356, 357, 357, 360, 369, 374, 377 ——— 381, 383, 394, 400, 409, 412, 426, 432, 437, 442 ——— 445, 446, 448, 452, 458, 461, 463, 469, 475, 481 ——— 493, 496, 496, 498, 502. Total 110.

Feb. 5—1, 3, 8, 10, 12 ——— 13, 18, 22, 22, 25, 28, 28, 28, 34, 36 ——— 37, 37, 41, 45, 46, 48, 52, 55, 57 ——— 59, 60, 60, 60, 60, 61, 64, 72, 76, 83 ——— 83, 84, 87, 88, 94, 96, 101, 103, 106, 109 ——— 110, 119, 126, 131, 135, 140, 141, 141, 148, 151 ——— 151, 152, 152, 158, 161, 164, 168, 174, 175, 188 ——— 200, 207, 207, 212, 220 229, 237, 244, rest period, 245, 245, 251, 252, 254, 255, 256, 259, 268, 281, 283, 301 ——— 321, 333, 338, 343, 377, 377, 379, 384, 388, 410 ——— 425, 425, 439, 461, 481, 482, 494, 496, 508. Total 104.

TABLE VI
(*Continued*)

Subject—H.

Experiment—Tossing and catching two rubber balls with right hand. Each practice was five hundred catches with five minutes rest near the 250th catch. The numbers at which the misses were made are given below.

Feb. 6—11 ——— 14, 15, 21, 24, 32, 38, 44, 45, 47, 67 ——— 72, 77, 82, 86, 90, 91, 92, 97, 99, 103 ——— 107, 111, 130, 143, 151, 168, 174, 182, 190, 205 ——— 219, 228, 255, rest period, 261, 280, 285, 311, 326, 333, 336 ——— 385, 391, 428, 430, 431, 433, 461, 475, 485, 501. Total 51.

Feb. 7— ——— 7, 17, 19, 21, 41, 60, 78, 96, 114, 132 ——— 135, 150, 166, 167, 175, 179, 181, 190, 195, 201 ——— 215, 223, 225, 225, 227, 240, 258, rest period, 263, 265, 268 ——— 273, 276, 290, 334, 356, 364, 377, 381, 400, 414 ——— 423, 444, 453, 455, 479, 486, 504. Total 47.

Feb. 8—2, 3, 11 ——— 13, 17, 27, 27, 30, 36, 41, 48, 60, 70 ——— 90, 94, 105, 107, 110, 121, 133, 141, 143, 150 ——— 150, 172, 203, 235, 267, rest period, 279, 286, 290, 300, 310 ——— 318, 322, 326, 334, 345, 375, 388, 400, 403, 407 ——— 435, 438, 441, 455, 489, 518. Total 49.

Feb. 10—16, 17, 20, 21 ——— 21, 28, 47, 110, 152, 160, 173, 196, 201, 202, ——— 209, 231, 235, 238, 246, rest period, 253, 260, 264, 267, 268 ——— 300, 330, 343, 346, 376, 401, 416, 432, 449, 452 ——— 510. Total 35.

Feb. 11—1, 98, 129, 130, 153, 165, 193, 213, 272 ——— rest period, 280, 287, 324, 339, 381, 421, 430, 442, 504. Total 18.

Feb. 12—39 ——— 60, 81, 100, 122, 176, 194, 221, 281, rest period, 290, 318 ——— 450, 489, 499, 560. Total 16.

Feb. 13—49, 93, 111, 116, 121 ——— 143, 182, 249, rest period, 274, 315, 368, 410, 431, 509. Total 15.

Feb. 14—0, 42, 69, 131, 190, 203, 238, rest period, 214, 264, 284 ——— 301, 338, 364, 367, 373, 389, 409, 418, 450, 453 ——— 460, 471, 535. Total 23.

Feb. 15—6, 21, 31, 59, 78, 88, 89 ——— 116, 135, 150, 169, 174, 185, 193, 199, 204, 205 ——— 244, 246, 247, 255, rest period, 257, 272, 285, 288, 289, 323 ——— 327, 344, 362, 369, 379, 383, 409, 427, 428, 438 ——— 472, 488, 494, 505. Total 41.

Feb. 16—56, 84, 124, 152, 158, 200 ——— 219, 223, 234, 242, 296, rest period, 299, 311, 350, 359, 386 ——— 391, 395, 402, 446, 497, 506. Total 22.

Feb. 17—15, 21, 44, 83, 130, 138, 163, 216, 261, rest period, 287, 309, 407, 428, 432 ——— 492, 524. Total 16.

Feb. 19—99, 130, 178, 208, 235, 252, rest period, 290, 328 ——— 352, 416, 428, 454, 518. Total 13.

Feb. 20—97, 159, 200, 240, 268, rest period, ——— 322, 352, 413, 459, 537. Total 11.

Feb. 21—31, 47, 61, 99 ——— 126, 131, 149, 150, 162, 180, 185, 216, 217, 233 ——— 243, rest period, 263, 267, 278, 337, 362, 373, 413, 415, ——— 434, 455, 460, 461, 523. Total 29.

Feb. 22—24, 54, 91, 91, 109 ——— 134, 145, 171, 220, 247, rest period, 261, 335, 377, 428, 436 ——— 456, 463, 474, 476, 477, 489, 494, 517. Total 23.

Feb. 23—15, 116 ——— 149, 186, 208, 237, 298, rest period, 340, 369, 434, 500. Total 11.

Feb. 24—32 ——— 61, 200, 205, 231, 322, rest period, 335, 449, 537. Total 9.

Feb. 25—86, 114 ——— 189, 234, rest period, 516. Total 5.

Feb. 26—53, 87, 187, 266, rest period, 348, 415, 435 ——— 551. Total 8.

Feb. 27—227, rest period, 435, 509. Total 3.

March 1—332, rest period, 550. Total 2.

The table shows the number at which the misses were made, that is in the first practice the subject caught one ball and missed the second one. The next trial he caught one more and then missed. This makes two catches as represented by the two. By

taking the difference between any two successive numbers, the number of catches made during that trial may be found. The breaks, marked "-------" in the columns divide the work into periods of ten trials each. This was done for convenience in plotting one of the curves. The last figures marked "total" show how many misses were made in that particular practice period.

The Plotting of the Curves

In order that the significance of these figures may be better understood, the curves which they represent have been plotted. Curves I, II, III, IV and V (Plate I) are plotted by letting the divisions on the x-axis represent the practice periods and the divisions on the y-axis, the number of catches. In Curves VI and VII (Plate II), the divisions on the x-axis represent the number of practice periods and the divisions on the y-axis represent the number of misses in the practice period. Curve VIII (Plate III), also, has practice period divisions on the x-axis and the number of catches on the y-axis. Curve VIII is obtained by taking the work of Subject H. and finding how many catches were made in each ten trials. Since he was not stopped at the end of any trial, the only difference between this and the first five curves is that the practice was differently distributed. Each practice period for Subject H. continued until he had caught five hundred or a few more than five hundred balls. In Curve VIII, each ten trials is called a practice period and given a space on the x-axis.

Curves IX and X (Plate III) are obtained by taking the second part of the work of Subject F. and the work of Subject H. and using the riciprocals of the number of trials for the divisions on the y-axis and the number of practice periods for the divisions on the x-axis. The number of trials and the number of misses are the same for Subject H. But for Subject F. one trial must be added in each hundred as the last one was not counted a miss. This places him at a disadvantage as he was not allowed to finish out his last trial. Under the given conditions these reciprocal curves have the same form as the curves that would be obtained by taking the average number of throws per

trial in the given practice period, which in these cases includes one thousand or five hundred catches for the divisions on the y-axis.

Curves XI, XII, XIII, XIV (Plate II) and XV (Plate III) are plotted by taking groups of one thousand tosses for the divisions on the x-axis and the average nuuber of catches per trial for the divisions on the y-axis. Tables I, IIa, IIb, III and IV are used as a basis for the data. Each table is divided into as many groups as there are thousands of catches. Where a thousand catches ended in the midst of a trial the number that was used out of that trial was used as a fractional part of a trial. For instance, if the first one thousand included the sum of the number of catches made in the first fifty trials and a half of the number of catches made in the fifty-first trial, then the whole number of trials for the first one thousand would be fifty and one half. This divided into the one thousand would give the average number of catches per trial in the first one thousand. In each of these tables there was a fractional part of a thousand left over. The curves do not show this.

Another way of handling the data was to divide the catches in each table into groups of one thousand each and then to find what per cent each thousand catches was of the total number of tosses for making a thousand catches. For instance, in Table I, it is found that in order to make the first thousand catches 1172 + tosses (1000 catches plus 172 trials) were necessaary. This gives 85 per cent of success. In each succeeding thousand as the number of trials per thousand catches becomes less the percent of success becomes greater. Curves were plotted on this basis and Curves IIa and IVa (Plate I) are typical examples.

Curves were also plotted by taking the highest score in each one thousand group for divisions on the y-axis and the thousand groups representing divisions on the x-axis. Curves IIIb and IVb (Plate I) are typical examples obtained in this way.

Discussion of the Curves

Curve I, II, IV, and V have a rather long period during which they rise but little. It took twenty practices for Curve I to rise above the one hundred level. Half of the number of prac-

tices were spent before the two hundred mark was reached. The drop in the curve at the twenty-fourth and the fortieth practices was the result of the room being cold. The drop at the thirtieth and thirty-third practices was caused by those apparently unaccountable bad days for which there was no reason that could be pointed out.

Curve II shows that the practice commenced further along. It is, however, slightly concave to the y-axis. Curve III has a more typical form for this method of plotting the work. There is a period of slow rise extending over more than half of the practice periods. The two hundred mark was not reached until the twenty-fifth practice. The thirty-sixth, thirty-seventh and thirty-eighth practices were on the three days just before the Christmas vacation and this seems partly, at least, to account for the drop here. It will be seen that after a period of eighteen days rest, the score on the thirty-ninth practice is nearly as high as it had ever been before.

Curve IV shows a very slow rise but without any very marked fluctuations. It took thirty-six practices for the subject to reach the two hundred mark, and he did not rise above it permanently until the fiftieth practice. The fluctuations between the forty-fifth and fifty-second practices represent the period just before and after the Christmas vacation. In this case there was a slight fall in the score immediately after the practices were resumed.

Curve V is peculiar in that it shows a very marked decline period. This is, no doubt, the result of too much effort. The subject was very anxious to reach the mark set which was to make an average of a hundred per trial for two consecutive days. After he made the score on the forty-ninth practice, he tried very hard to make a thousand catches in the ten trials on the next day. He said that his attention was so set on making a thousand catches that he forgot how to throw. His failure caused a temporary period of despondency. He thought he never could reach the mark set.

The higher level from the nineteenth to the thirty-fourth practice may be explained by the fact that the practices were daily;

before this time they had been on alternate days. The curve shows a somewhat higher level at first than do the other curves. This is possibly due to the subject's previous practice.

Curves VI and VII show a very rapid drop at first and then a slower fall toward the end. The fluctuation in Curve VI, perhaps, would not have appeared had the subject not had to practice in a cold room and had he been in a good physical condition. Curve VII has two marked rises. The first marked rise at the eleventh practice is the result of subject's being in a bad physical and mental state. At this practice he stated that he had had a disagreeable conversation just before and that he was all "worked up." He had been up late for several nights. He stated that his head and eyes ached and that he had no control of his hand. The next night he said that he was all worn out, that he had a cold and that he did not think he would ever be able to get below the mark that he had already set.

The rise at the seventeenth practice was due to the subject being in a hurry to get to orchestra practice. In these cases where the practice period is long, it appears that the fluctuations under normal conditions would be rather small. Subject H. felt confident after he had finished that if he had not tried to take the practice under adverse conditions, he would have had a nearly smooth curve.

When the work of Subject H. is reduced to a ten trial basis, the form of the curve does not differ greatly from the first five curves. It does not appear that the heaped up practice has any effect on the general form of the curve. In the curve only six trials are represented on the last division of the x-axis and yet the score for these six trials is more than twice as large as that for any other ten trials.

When the reciprocal of the number of trials is used as a measure of the skill, the curves take the form of IX and X. As has been stated, Curve IX is defective because the last trial in each hundred is not complete. The subject was stopped when he reached a hundred.

Curve X has a form similar to the first five curves,—that is it is concave to the y-axis. It has a slow rise at first and a rapid rise at the end.

Curves XI, XIII, XIV, and XV are all to a certain extent concave to the y-axis. By taking groups of a thousand instead of ten trials as a basis for the divisions on the x-axis, the early part of the curves rise more rapidly but even in these cases the latter part of the curves shows a rapid rise.

Curve XII corresponds to Curve II plotted by letting the ten trials represent the divisions on the x-axis. In this case where the groups of one thousand represent the divisions on the x-axis there is a slight convexity to the y-axis. It approaches more nearly a straight line.

Curves IIa and IVa rise rapidly at first and then approach parallelism with the x-axis. Curves obtained by taking the highest score in each one thousand group as a basis for divisions on the y-axis, of which Curves IIIb and IVb are examples, approach a straight line in general form. In none of these curves is there evidence of an arrest period of any considerable length between two periods of rapid rise.

Discussion of Results

It was the intention in this part of the work, to change the conditions so as to give a chance to analyse the factors involved and thus to get a better idea of how they influence the acquisition of skill.

Experiment—I: The purpose here was to get a curve for comparison where no directions were given and the subject was free to learn as he pleased. The first difficulty he noticed was his inability to throw the balls properly. This was such a bother that it was necessary to move to a larger room on the third day. This did not seem to aid any as he made a lower score on that day than on the day previous. The subject had great confidence throughout the work and was always sure that he was going to do better than on the preceding day. He noticed after the third trial that he fixed his attention on the ball at its highest point. On the twentieth day, when he reached a score more than twice as large as he had ever made before, he could give no other reason for the improvement than that they just seemed to fall

right. A cold room had a very marked effect upon the score as is shown by the result on the twenty-fourth and fortieth practice days.

Experiment—II: After two trials the subject had control of the manner of throwing to a large extent. In the fourth trial, all the attention apparently was centered on the throwing and the trouble came in the balls rolling out of the hand. In the fifth trial there was a greater feeling of confidence. The subject knew that he had reached a higher level of ability. At the ninth trial there was trouble because of the balls hitting together in the air. This difficulty lasted until the end of the practice. If the thought of their hitting together came up, they were almost sure to do so.

When the left hand was used, it was just the same as beginning all over again. The ability to grasp the ball came slower. It was noted at the eighteenth trial that this power had increased. It was also noted at that time that there was increase in ability to place the hand so as to receive the ball.

Experiment—III: The subject's first object was to pitch in a curve from right to left. His eyes seemed to follow the ball in its course and then with a quick jerk he threw the second ball and attempted to catch the first. The tendency was for him to follow the ball around in a circle from right to left. He was encouraged to follow the plan of pitching rather than to aim to make a high score. In the third trial, he thought there was no hope; his trouble was all in catching. He was still urged to give all his attention to throwing and get that under control first. In time, he did succeed in mastering the plan of throwing but an improvement in all the other elements of the work went along with this improvement. The subject was very sensitive to a cold room and the low score on Dec. 14 was the result of this. The missing of a few practices did not seem to effect the score either way to any great extent. After the Holidays, when the practice had been discontinued for seventeen days, his score fell slightly below what it had been the last two days before the vacation but these had been unusually high.

Experiment—IV: The purpose in using hard rubber was to

compel the subject to throw in a certain way. At first there was a tendency to throw the pieces so far away that he could not reach them. At the ninth trial on the first day, he commenced to throw in a circle from right to left. On the sixth day, he changed his plan of throwing because the pieces had whirled end over end. He now tried to pitch them straight up and let them fall flat on his hand. On Nov. 30, the low score was made because the subject was trying out a new plan of throwing. He now let the pieces roll off the ends of his fingers. He continued to use this method but in most cases when the pieces did whirl end over end he was able to get them started properly and would thus recover.

In the practice of all the subjects, a large part of the improvement seemed to be in their ability to get out of tight places. Ordinarily the throwing would go smoothly for some time until a bad pitch or catch would put one in a difficult position to make the next move. Early in the practice, this would mean a miss, but later the subject would be able to recover and get them going correctly. Subject F. thought his ability to get out of bad places was due to his giving attention to the next throw rather than centering all attention on the catch about to be made.

In the second part of this experiment, the object was to see the effect of giving a longer practice period. These results are shown in Curves VI and IX.

Experiment—V: This experiment had the same object as the second part of the experiment above. The subject was not at all given to any form of athletic work and took but little interest in physical exercise. He tried to study every phase of the work. At first he had very little confidence in his ability to do the catching. In the second practice, he noticed that he recovered a number of times from bad places. In the fourth practice, he found that the chief trouble was fatigue. He now felt confident that he could make a good score.

Taken as a whole, the subjects were affected more by subjective and objective factors in the beginning of the work than after they had reached a high degree of efficiency. The subject's feeling that he was going to make a high score was no

guarantee that he would do so. At times both high and low scores were made without the subject being able to account for them. An extra effort had no noticeable effect in increasing the score. In the early practice, there was a great amount of useless effort. The other hand would work in harmony with the one that was being used, the feet would be shifted with every catch, and the whole body seemed to be affected. When the skill, became greater, the unnecessary movements dropped out. They would return, however, when the subject found himself in a tight place but as soon as he got control they ceased.

By a study of the curves, it is seen that an attempt to give attention to different phases of the work does not modify the general form of the curves for this work. There seems to be scarcely any room for doubt that although some one factor may be picked out and emphasized, all the elements improve together. In this work having a method did not help much and nearly all the improvements were made accidentally and then adopted.

The Warming up Process

A good idea of this may be obtained by taking the sums of the trials separately for the different subjects. The following are the figures:

	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Subject—D.	1134	943	1357	1261	1169	958	1157	1616	1115	1396
" B.	927	1359	1244	1189	1372	1416	1340	1245	1075	1752
" B.	1210	1495	1470	1416	1611	1241	1233	1332	1142	1466
" W.	1458	1978	2051	2097	2338	2079	1793	2184	1883	2008
" F.	1409	2800	2232	2410	2466	1885	2340	1752	1852	1951
Total	6138	8575	8354	8373	8956	7379	7881	8129	7066	8573

From the figures in the total, it is seen that the first trial falls almost a thousand below any other trial. In three cases it is below any other of the ten. In the other two cases it is below the average for the ten.

Relearning

None of the subjects shows any considerable loss for a long rest period. Subject D., on Aug. 15, after a rest of 265 days, was able to make a score higher than any he had ever made before excepting the first three at the end of the practice where he had made a sudden rise. Two days afterwards without any further

practice he was able to make a score that almost equalled his last practice score. After nearly a year (327 days) more had elapsed, he was able to make the very high score of 2550 which was almost twice as high as he had ever made before. Here the only thing that seemed to bother him was the fatigue.

Subject-B. after more than a year's rest (613 days) made nearly as good score with the right hand as he had ever made before. He was sure he could have exceeded any previous score if he had not fatigued himself so much by the first throw (score 329). After that he could not grasp the balls so well. After the beginning of each trial was made the work went along without much trouble. The next day, he surpassed any previous record with a score of 1437. Here the fatigue element, especially that of the eyes, was very annoying.

The left hand, after a period of 612 days, seemed to have lost more. The process seemed very strange and the subject had no confidence that he could do it. Even in this case the score did not fall much below what it had been before the last two times in the regular practice. Two days later the subject was able to make a score of 702. This exceeded any score he had previously made except the last three of the regular practice.

Subject-W., after a rest of 134 days, was able to reach a score higher than any he had before made except the last four in the regular practice. The next day he exceeded all previous records. After a period of 371 days from this practice he was able to make a score higher than any he had ever made before. The only explanation he gave for this is that he had been out playing tennis and felt especially well that morning.

Subject F., after a period of 143 days seemed to have dropped to a level that preceded his last two practices. The next day he was not able to do so well. The first day he started out confident that he would exceed an average of a hundred catches per trial but after a bad run in the seventh trial he became discouraged as the figures show.

Taken as a whole the results show that there remains for long periods of time after practice ceases an ability about equal to what it was at the end of the practice. In some cases it seems

to increase and in nearly all cases is capable of a very rapid increase when practice is commenced again.

The Total Amount of Practice

In the first five experiments, attention has been called to the amount of practice that passed before any great amount of advance was made. This must not be taken to mean that a proportionate part of the practice time had passed. In the trial method, the first ten trials gave but very little practice. The amount of actual practice increased as the ability increased. This, of course, is not the case where a certain number of catches had to be made each day or practice period.

The total number of catches gives an idea of the total amount of practice and may be a truer index of the subject's ability to improve. It is seen from these figures that Subject D. took the least practice (12124 catches) although he took more practice periods than did Subject B. The figures show further that Subject B. improved almost as fast with the left hand as with the right hand, the catches being 13617 and 12919 respectively. However, the practice with the left hand is distributed over a longer period. This might mean that the left hand improves about as fast as the right hand or that the longer distribution has the advantage.

Subject W. took 20180 catches to gain the degree of skill required of the other subjects. Subject F. took 21098 catches but his work was much more difficult.

THE EFFECT OF AN ISOLATED FACTOR

While doing the work just discussed, it was noticed that several factors influenced the subject's progress. At least three of these could be easily picked out. It has already been noticed that the ability to throw the ball so that it could be reached was an important element in the learning. This judgment of direction or the ability to throw properly is one of these elements.

Again, the force with which the balls were thrown was important. If the ball was not thrown high enough, it would return before the other could be thrown. Not all the subjects

used the same force, or in other words pitched the balls the same height, but they soon fell into some habit of pitching and when the work was going smoothly, about an equal amount of force was put into each pitch. The element of force was the second factor to be noticed.

The third element is that of time. It has been stated that the eye saw the ball only at the highest point of its upward motion and a short way down on its course. The absolute eye movement was not measured but by watching the subject's eyes it was seen that they scarcely moved in a vertical line. It was necessary for the subject to learn to catch the ball by timing it from the time it left the field of vision until it reached the hand. That this was the case is shown by the subject's inability to grasp the ball at first when it hit his hand or by his closing the hand too soon and permitting the ball to hit the ends of his fingers. That this grasping is not simply a reflex that takes place after the ball hits the hand is further shown by taking a practiced subject and intercepting the ball after it leaves the field of vision but before it reaches his hand. It was found that the hand closes even though the ball does not touch it.

These three elements, judgment of direction, judgment of force, and judgment of time, have been selected for further study. The aim was to discover the nature of the improvement of these factors when isolated and trained in as simple a form as it was possible to devise.

Experiment I. On Direction

Two subjects took part in this experiment: Subject D. (DeCamp) and Subject W. (Wang) had both been subjects in the ball tossing experiments. The apparatus consisted of a smooth board, a steel ball, and a small block of wood. The board was fifteen inches wide and about fifteen feet long. Forty and one half inches from one end of the board a line was drawn across at right angles to the side. On this line, inch spaces were marked off and numbered from zero out on one side to plus seven and on the other side to minus seven. Seven and one half feet from this line another line was drawn across the board. The board

was three and one half inches higher at the first mark than at the second mark.

The steel ball was one inch in diameter and weighed 66.8 g. The block of wood was two and one half inches long and seven eights of an inch square. This was set up on the zero mark as a target. The subject stood at the lower mark and rolled the ball at the block of wood. His score was kept in figures as +1, —3, etc. accordingly as the steel ball passed through these numbers or spaces.*

Subject W. commenced this work on Apr. 14, 1913 and continued it until May 18, 1913. The practice was daily in the forenoon and consisted of fifty trials. The result of this work is shown in Table VII.

TABLE VII

Subject—W.
Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

April 13. 0, 2, 1, 0, 2, —7, 2, 0, —1, 1, 0, —7, 6, 2, 1, 2, 1, 3, 0, —5, 1, —2, 3, 0, —2, 3, 5, 0, 0, 0, 0, 2, 2, —4, 0, 2, —5, 0, 0, —2, 4, 0, 0, 3, 3, 3, 0, 0, 0, —1 = 90.

Apr. 14. 0, —4, —4, —2, —3, 2, —1, —1, 0, —2, 0, —2, —2, —1, —1, 0, 0, 2, —2, 0, 1, —2, 0, —1, 0, 0, 2, 2, 1, —2, —3, —2, —1, —2, 0, 0, —2, 0, 0, 2, 3, —2, —1, 0, 0, —2, 1, —1, 0, 1 = 63.

Apr. 15. 2, 2, 1, 0, —1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, —1, 1, —5, 4, 2, 0, —3, —2, 1, 2, 2, 1, —1, 0, 0, —1, 0, 0, —3, 7, 0, —3, —4, —4, 0, 0, —1, —1, —3, 0, —3, —4, —3, —2, —1 = 73.

Apr. 16. 1, 0, 1, 2, 2, 0, 2, 2, 0, 0, 0, —1, 0, 0, —1, 1, 0, —3, 0, 0, 0, —4, 0, —1, 0, 0, 0, —1, —2, 0, —1, 0, 0, 0, —2, —2, 2, —4, 1, 0, 1, 0, 2, 0, 0, 1, —1, —2, 1, 1 = 44.

Apr. 17. 1, 2, 0, —1, —1, 2, 1, 2, 1, 1, 0, 0, 1, 2, 2, 0, 1, 0, 0, 0, 0, 0, 4, 2, 0, 1, 0, —3, 2, 1, 1, —3, 0, —1, 0, 0, 0, 0, 0, 0, —1, 0, 1, 0, 1, 0, 1, 2, —2, —5 = 49.

Apr. 18. —2, 2, 1, 0, 1, —2, 0, 3, 0, 1, —4, 0, 1, 0, 1, 1, 0, 0, 0, 0, 2, 0, —1, —2, 0, 0, 0, 0, —1, —3, 1, 2, 1, 0, 0, —2, 1, —3, —1, —1, 0, —4, 2, 0, 0, 0, —1, 0, 0, 0 = 47.

Apr. 19. 1, 1, 2, —5, —3, 0, —2, —2, 0, —3, 0, 5, 2, 2, 0, —4, 2, 0, 0, —5, 0, —3, 1, 1, 0, 2, 0, 1, 0, 0, 0, —3, —1, 0, —1, 0, 0, 0, 1, —1, 2, 0, 0, 4, 0, 3, 0, 1, 0, 1 = 65.

Apr. 20. 2, 2, 2, 0, 1, 0, —2, —4, 1, 0, 2, 0, —1, —2, 2, 0, 0, 2, 0, 0, 0, —2, —2, 2, 2, 2, 2, 0, 0, —1, 1, 0, 1, 0, 0, 0, —2, —3, 0, —2, 0, 0, —1, —2, 1, 2, 0, 0, 0, 0, = 51.

Apr. 21. 0, 0, —1, 0, 1, 0, 1, 0, 0, 0, 1, —1, 0, 0, 0, —3, 2, 2, 1, 0, 3, 2, —2, 2, 0, 2, 1, 0, 0, 2, 0, —2, 0, —1, 1, 0, 0, —3, 2, 0, 1, 2, —1, —1, —2, 0, —1, 3, —1, 0 = 48.

Apr. 22. 2, —2, 0, 1, 0, —1, 0, 0, 0, 2, 0, 0, 0, 0, —2, —1, —3, 1, 0, 0, 0, 1, 0, 2, 1, 0, 0, 0, 0, —3, 1, 1, —2, 0, 0, —1, —3, —4, 0, —1, 0, 1, 1, 1, —1, 0, —2, —1, 0, 4 = 46.

* In order for these figures to correspond to the value they represent, the divisions should have been weighed according to the divisions on the base line of the curve of probability. But as there were relatively few high scores the error in the final result was negligible.

TABLE VII
(*Continued*)

Subject—W.

Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

Apr. 23. 0, —1, —1, 0, —2, 0, 2, 1, —4, 2, 2, —2, 0, 1, 0, 0, 0, —1, 0, 0, 2, 1, 2, 2, —1, 2, 0, —4, 0, 2, 1, 1, 0, 0, —1, —2, 2, 1, 1, 0, 1, 0, —2, 0, 0, 1, —1, —3, 1, —3 = 56.

Apr. 24. —1, 0, —2, —1, 0, —3, 1, 0, —1, 1, —1, —3, 0, 0, 0, 0, 1, 0, 0, 1, 0, 2, 1, 0, 0, 2, 0, 0, 0, 0, 0, 0, 2, —5, 0, 1, 2, 0, 0, 1, 2, 2, 2, 0, 1, 0, 0, 1, 2, 1 = 43.

Apr. 25. 0, 1, 2, 0, 1, 0, 0, 1, 0, 1, 0, —1, 0, 4, 1, 0, 1, 1, —4, 1, 0, —1, 0, —2, 0, 0, —7, 3, 1, 0, —2, —2, 0, —2, 0, —6, 0, 0, 1, 1, 0, 0, 0, 0, —1, 0, 0, —3, 0, = 51.

Apr. 26. 3, —1, —6, 2, —3, —2, 0, —1, 1, 0, —2, 1, —2, 0, 1, 0, 1, 0, 1, 0, 0, 3, —4, 0, 0, —3, —3, 1, 0, 0, —2, —4, 1, 0, —3, —1, 0, 2, 1, 0, 0, 1, 0, 0, 0, —4, 1, 0, 2, 0, 2 = 65.

Apr. 27. 1, 0, 1, 1, 2, 2, 0, 0, 0, 2, 1, 1, 2, 2, 3, 1, 0, —1, —4, 0, —4, 1, 2, 0, 0, 0, 1, 4, 0, —2, —4, 0, 0, —3, 1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 0, 1, —3, 1, —1, 0 = 57.

Apr. 28. 0, —3, 0, 0, 0, 1, 0, —4, —1, 0, 0, —2, 0, 0, 1, 0, —2, 0, 0, 0, 0, —1, 0, 5, 0, —3, 0, —4, 0, 1, —2, 1, 0, —1, 1, 0, —4, —2, 1, 0, 0, 1, 0, —1, 0, —1, 1, 0, 0, 0 = 44.

Apr. 29. 1, 1, 2, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, —3, 0, 0, 0, 0, 0, —2, 0, 2, 0, —2, —2, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, —1, —2, 2, 0, 0, 1, 0, —2, 0, —1, 0, —3, 0 = 32.

Apr. 30. 0, 1, 0, 0, 0, —2, —2, —3, 0, 1, 0, 2, —2, 1, 0, 0, 0, —1, 1, —4, 0, —2, —2, 0, 1, 0, 0, 2, 0, —2, —4, 1, —1, —1, 0, 0, —1, 0, 1, —2, 0, 0, 0, —2, 1, —2, 0, —1, 0, 0 =46.

May 1. —1, 0, 0, 1, 0, 1, —3, 1, 4, 0, 1, 0, —2, —2, 0, —2, 1, 0, 2, 0, 1, —1, —4, 0, —1, —3, 0, 0, —5, 0, 0, 0, 0, 0, 0, —1, —1, —3, 1, —2, 0, 0, —1, —4, —1, —2, —3, 0, 1, 0 = 56.

May 2. 1, —4, 0, 0, 1, —4, 0, —3, —4, 1, —1, 0, —1, 0, 0, —1, 0, 0, —4, 0, 0, 0, 0, 0, —5, —2, —1, 0, 0, 0, 0, 1, 1, —3, 0, 0, —1, 0, 0, 0, 0, 0, —1, 0, 0, 0, 0, 1, 0, —1 = 42.

May 3. 3, 0, 1, 0, 0, 1, —2, 1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, —1, 0, 0, 0, 1, 0, 0, —,1 0, 0, 0, 1, —3, 1, 0, 1, 2, 0, 1, 0, —1, 1, 0, 0, —1, 0, 0, —2, 0, 0, —1, 0 = 30.

May 4. 0, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, —3, —1, —3, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0, —1, 0 = 13.

May 5. 0, —1, 0, —1, 0, 1, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, —3, 0, —4, 0, 0, —2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —3, 0, 0, 0, 1, 0, 0, 0, 0 = 18.

May 6. 1, 0, 0, 0, 0, 0, 1, 1, —3, —2, 0, —2, —4, 0, 0, —1, 0, —1, —1, 1, —3, —1, —1, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —4, 0, 0 = 28.

May 7. 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, —2, 1, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, —3, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0, 0, 0, 0, —1, 0, 0 = 14.

May 8. 0, 0, 0, 0, 0, 0, —2, 0, 0, 0, 0, 0, 0, 1, 6, —3, 0, —1, 0, 0, —1, 0, 0, 0, —1, 0, 1, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 = 22.

May 9. —1, —1, —3, —1, —1, —2, —1, 0, 0, 0, 0, 2, 0, 0, 0, 3, 0, 0, 0, 3, 0, 0, 0, 2, 0, 0, 2, 0, 0, 0, 0, 0, 1, —2, —1, —1, 3, 0, 0, —1, 0, —1, —1, 0, 0, —1, 0, 0, —2, 0 = 36.

May 10. 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 2, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —3, —2, 0, 0, 0, 0, 0, 0, 0, 0 = 16.

TABLE VII
(*Continued*)

Subject—W.
Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

May 11. 0, 0, 0, 0, 0, 1, —1, 0, 0, 1, 2, 0, —3, —1, 0, 0, 0, 0, 0, 0, 0, 0, —2, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 = 13.

May 12. 0, 0, 0, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, —1, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0 = 5.

May 13. —1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, —1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0 = 9.

May 14. 0, 0, 1, 0, 0, —1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —3, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, —1, 0 = 9.

May 15. 1, 1, 0, —3, —3, 0, —2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 = 12.

May 16. 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,0, 0 = 1.

May 17. —1, 3, 1, 0, 0, 0, 0, 0, 0, 0, —1, 0, —1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0 = 9.

May 18. —1, 0, —1, 0, —1, 0, 0, 0, 0, 0, 0, 0, —1, —1, 0, —1, 0, —2, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 = 11.

May 19. 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, —1 = 12.

Subject D. commenced work on Apr. 17, 1913 and continued until May 22, 1913. His practice was in the forenoon and consisted of a hundred trials. The results of his work are shown in Table VIII.

TABLE VIII

Subject—D.
Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

Apr. 17. —2, —2, —3, —1, —1, —2, 0, 0, 0, 1, 0, 0, 0, —1, 0, 1, 2, 0, 0, 0, 0, 0, —1, —2, 0, 0, 0, 0, 0, 0, 0, —1, —1, 0, 0, —3, 1, 2, 0, 0, 0, 1, 0, 0, 0, —1, 2, 2, 0, 0, 1, 0, 0, 2, 0, 0, 1, 0, 0, 3, —2, —2, —1, 1, —4, 3, 1, 3, —1, —3, 1, 0, 2, 2, —2, 0, 0, 0, 2, 6, —1, —2, 0, —2, 0, —2, 5, 0, 3, 4, —3, 0, 1, 0, 2, 0, 0, —1 = 104.

Apr. 18. —4, 2, 0, 2, 3, 2, 0, —3, —1, 5, —1, 0, 0, —5, 0, —4, 3, 0, —1, —5, 0, —1, —2, —2, 0, 0, —1, 4, 0, 0, 0, 2, 0, —3, 0, —2, 2, —1, 1, 2, —2, 0, —3, —1, 2, 0, 3, 3, 0, 1, 0, —1, —1, 0, 0, 1, —1, 0, —1, 1, 0, 3, —1, —3, 0, —1, 0, 0, —1, —3, —1, —1, 1, 0, 2, 0, 0, —1, 3, 0, 2, 0, 2, 0, 0, 2, —1, 0, —1, 0, —2, —1, —1, 1, —1, 2, —1, 0, 2, 0 = 125.

Apr. 19. —3, 0, 4, 0, 1, 0, 0, 2, —7, 0, 0, 1, 2, —1, 1, 2, 0, 1, —3, 3, 0, 5, 0, 1, 1, 0, 1, 1, 0, 1, —3, 0, 0, 0, 0, 0, 1, 0, 3, 1, 1, —1, 1, 1, 3, 1, 1, 1, 4, 0, 2, 0, 0, 0, 0, 2, 2, 3, 0, 3, 0, 0, 0, 2, 1, 0, 1, 0, 1, 1, 3, 0, 0, 3, 1, 0, 1,

TABLE VIII
(*Continued*)

Subject—D.

Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

2, 0, 0, 0, 3, 0, 0, 0, 1, 4, 4, 2, 0, 0, 3, 4, 0, 1, 2, 2, 0, 0, 5 = 122.

Apr. 20. 3, 2, 1, 1, 0, 1, 4, 1, 1, 2, 1, 3, 1, —1, 1, —1, 3, 2, 4, 1, 2, —2, —3, 2, —2, 0, 0, 0, 0, 2, 3, 1, 2, —2, —2, 0, —1, 1, 1, 2, 2, —1, —1, 0, —1, —2, 0, —1, 0, 1, 3, 5, —4, —1, —4, —3, —2, 0, 0, —1, 0, 1, 2, —2, —3, —1, —1, 1, 0, —1, —1, 3, —3, 0, 1, 2, —3, —1, 1, —4, —3, 1, 1, —1, —1, —1, 0, —2, 0, 1, 0, 0, 2, 0, 2, 0, 0, 0, 2, 0 = 142.

Apr. 21. 0, 1, 3, 0, 0, 2, 3, 2, 0, 1, 0, 0, 1, 0, 2, 0, 1, 0, 1, 3, 0, —2, 0, 1, 0, —2, 2, 1, 0, 0, 0, 1, 0, 5, 0, 0, 0, —2, —1, 0, 0, 1, 0, 1, 1, 0, 1, —2, 1, 4, 0, 0, 0, —1, —1, 0, 0, 0, 0, 0, —1, 0, 5, —6, 0, 2, 0, 0, 0, —3, —1, —2, 0, —1, 2, 0, 0, —1, 0, 2, 3, 3, 0, 0, 0, 0, —1, 0, 0, 0, 1, —3, 1, —1, —1, 4, 0, 0, 1, 0 = 95.

Apr. 22. 2, —2, —1, —3, 0, 0, —2, 3, 0, 6, 0, 1, 0, —2, 1, 0, 1, —1, —4, —1, 1, 2, 0, 3, 2, 0, 1, 2, 0, 0, 1, 6, —2, 1, 2, 1, 0, —1, —3, 0, 2, 2, 2, 1, 2, 2, 0, 2, —2, 1, 3, 1, —1, 2, 2, 0, 0, —1, 1, —1, 2, 0, 0, —1, 1, —2, 0, —1, 0, 0, 1, —1, 2, 0, —2, 0, 0, —1, 2, —1, —1, 2, 1, —1, 0, —1, 0, 3, 0, —1, 0, 0, 2 = 122.

Apr. 23. 2, —2, 0, —2, 0, —2, 0, 0, 0, —2, 3, 0, 2, 0, 0, 4, 0, 0, 0, 0, 3, 0, 2, 1, 1, 0, 0, 2, 2, 0, 0, —1, 0, 0, —1, 0, 2, 0, 0, 2, 2, 3, 1, 2, 0, 0, 0, 4, 1, 0, 0, 0, 3, 0, 2, 2, —3, 2, 3, —1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, —3, 2, 0, 1, 3, 4, 3, 2, 0, 0, 0, —1, —1, —2, 0, —1, 0, 0, 0, 0, 0, 0, 0, —3, 2, 0, 0 = 96.

Apr. 24. —3, —2, 0, —1, 0, 0, 1, 2, 1, 0, 2, 0, 2, 2, 0, 0, 2, —1, —2, 3, 3, —2, 0, 3, 0, 0, —3, 0, —3, 3, 0, —2, 3, 3, 2, 0, 0, 0, 1, 4, 0, 0, —3, 3, 1, 0, 0, 0, 2, —2, 3, 1, 2, 0, 1, 0, 0, —2, 0, —3, —1, 1, 0, —2, 0, 3, 0, —3, 4, 0, 0, 3, —1, —2, —2, —1, 1, 0, 1, 0, 2, 5, 0, 0, —1, 2, 1, 0, 0, 1, 4, 0, 0, 0, —2, 0, 1, 0, 0, —1 = 124.

Apr. 25. —1, 0, 0, 0, 3, —1, 0, 0, 3, 1, 4, 0, 3, 3, 2, 0, 0, 0, 0, 1, 2, 4, 4, 0, 1, —1, 2, —1, 2, 1, 0, 2, 2, —3, 0, —1, 0, 2, 0, 0, 2, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 3, 3, 4, 2, 0, —1, 1, 3, 1, 0, 0, 0, 0, 0, 1, 2, 0, —1, 2, 1, 0, 2, —1, 0, 0, 2, 0, 1, 0, 1, 0, 0, 0, 1, 1, 2, 2, 3, 1, 0, 0, 0, 1, 2, 1, 0, 1, 1 = 102.

Apr. 26. 0, —3, 2, 0, 0, —2, 0, 0, 0, 2, 0, —3, 0, 1, 0, 0, 1, 0, 2, 0, 2, —5, 0, 0, 0, 0, 0, —2, —1, 2, —1, 4, —1, 0, —2, 0, —3, —2, —1, 0, 0, —3, —1, 0, 0, 0, 0, 0, 0, —3, 0, 0, —2, 0, 0, —3, 0, 0, 2, —1, 2, —1, 1, 0, —1, 0, 0, 0, 0, 0, —2, 0, 0, 1, 0, —2, 1, 1, 2, 0, —2, 3, 1, 0, —2, —1, 0, —1, —1, 0, 0, 2, 0, 0, 0, 0, 0, 0, —1, 0 = 84.

Apr. 27. 0, 0, 0, 2, 2, 0, 3, —1, 0, 0, 0, 2, 2, 7, —2, —1, —2, —3, 0, —2, —2, 0, 1, 1, —3, 0, —3, 1, 1, —1, —1, 2, 0, —1, —1, 0, 2, 1, —2, 0, 0, 0, —2, —1, 0, —1, 1, 0, —1, 0, 1, 4, 0, —3, 1, —1, 2, 1, 0, 2, 0, 0, 2, —1, 0, —3, 0, 0, 1, 3, 0, 0, —1, 0, 2, —1, —1, —1, 0, 0, 1, 2, 0, —3, —1, 1, —1, 0, 1, 0, 0, 2, 1, 0, 2, 0, 3, 0, 0, 0 = 107.

Apr. 28. 2, 3, 3, 0, 0, —1, 1, 0, 3, 2, 0, 0, 0, —1, 0, —2, 0, 0, 2, 0, 0, —2, 2, 2, 0, 2, 0, —1, 0, 2, 0, 0, 0, 2, 0, —2, 2, 0, —2, 3, 0, 0, 0, —1, 1, 0, 1, —5, 2, 0, 0, 3, 0, —1, 2, 1, —1, —4, 0, 0, 0, 2, 0, 0, 0, 0, 0, —1, —1, 0, 0, 0, —1, 0, 2, 0, 0, 0, 1, 0, 0, 0, 2, 0, 3, 0, 2, 0, 0, 2, —2, —1, 2, —1, 0, 0, 2 = 89.

Apr. 29. —1, —1, 0, —1, 0, 0, 1, 2, 4, 1, 0, 0, 0, 0, 2, 0, —1, 0, 0, —4, 0, 0, 1, 1, 0, 0, 1, —2, 2, —1, 0, 0, 1, —2,

TABLE VIII
(*Continued*)

Subject—D.

Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

2, 0, 2, 0, 3, 0, 0, 2, 1, 3, —1, 0, 0, —1, —3, 0, 1, 0, 2, 1, —1, 3, 3, 0, 2, 0, 5, 3, 1, 0, —1, —1, 0, —1, —1, 0, 0, 2, 0, 1, 1, 1, 1, —1, 0, 0, —1, 0, 0, 0, 4, 1, 4, 0, 0, 0, —2, 0, —3, —3, 0, 1, 2, 2, —1, 0 = 104.

Apr. 30. 3, 2, 0, —3, —1, 2, 1, 0, 0, 1, —2, 5, 0, 2, 3, 0, 0, 1, —4, —1, —1, —2, 0, —2, —1, 2, 0, 1, 2, —1, —1, 0, 1, 0, 1, —1, 2, 2, 0, 0, 0, 1, 0, 0, 2, 0, 1, 2, 0, —1, —1, 5, 2, 0, —3, 2, 0, 0, —1, 0, 0, 0, —1, 0, 0, —2, 0, 0, —1, 0, 0, —2, 1, 0, 3, 5, 2, 1, 0, 0, 0, 0, —2, 0, 0, 1, 0, 0, 0, 0, —1, —1, 0, 0, 1, 1, 2, 2, 3, 0 = 104.

May 1. 2, 0, 2, 0, 0, 1, 2, 1, —2, —2, 1, 0, 1, 2, 0, 3, 0, 0, 3, —3, —3, 2, —2, —3, 0, 1, —1, 2, —3, —1, 1, 0, 0, 1, —3, —1, 1, 0, 1, 1, 0, 2, 1, 4, 0, 0, 1, —3, 0, 1, 4, 0, 0, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0, 1, 4, —1, —1, 1, 0, 1, 0, 7, 0, 0, —3, 1, 0, 2, —1, 5, 0, 1, 0, 1, 0, 1, 0, 2, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0 = 105.

May 2. 0, 0, —1, 0, 1, 5, 1, 2, 0, 0, 1, 0, 0, 2, 0, 1, 0, —1, 0, 0, —1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 2, 2, 1, 0, 0, —1, 2, 0, 0, 1, 2, —1, 0, 3, 1, 0, 2, —1, —1, —2, 0, 0, 1, —1, 0, —1, 0, 0, 0, 2, 1, —2, 2, 2, 0, 0, 1, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3, —1, —1, 0, 3, 0, —1, 0, 2, 0, 3, —3, 4, 3, —1, 0, 1, 0, 1 = 82.

May 3. —2, 4, 0, 5, 3, 1, 1, —1, —2, 0, 0, 2, 1, 0, —2, 0, 0, —3, 1, 0, 0, 1, —1, —1, 0, 0, 0, 0, 1, —1, 0, 2, 3, 1, 3, 2, 0, 3, —1, 0, 0, 0, 2, 0, 0, 2, 0, 0, —1, 3, 4, 3, 0, 0, 2, 3, 1, 0, 1, 0, 0, 0, 2, 0, 0, 0, —3, 1, 0, —3, 0, 1, 0, 0, 1, 0, 0, 0, 3, 1, —3, 1, 0, 1, 2, 1, 0, 0, 0, —2, 2, 2, 0, 2, 4, 0, —2 = 107.

May 4. 0, 1, 2, 2, 2, 2, —1, —1, 0, 0, 0, —1, 3, 0, 3, 3, 0, —1, 0, —2, 0, 0, 2, 0, —4, 0, 2, 0, 5, —4, 0, 0, 2, 0, 0, —1, 2, 1, 0, —2, 0, —2, 0, —1, 0, 0, —2, 0, —1, 0, —1, —1, 0, —1, 0, 0, 0, 0, 7, —2, —5, —3, —5, 0, 0, 0, 0, 0, —1, 0, 0, —1, 2, —2, 0, —2, 4, 1, —1, 2, 1, 2, 1, 3, 1, 2, 0, 0, 0, 0, —1, 1, 0, 1, 2, 2, —2, 1, 0 = 116.

May 5. 0, 1, 3, 5, 0, 0, 0, 0, 2, 0, 0, 0, 2, 0, 1, 2, 1, 1, —1, 3, 2, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, —1, 0, 0, 2, 0, 0, 3, 0, 0, 1, 0, 2, 0, 0, 0, 0, —2, 0, 0, 0, 0, —1, 0, 5, 2, —1, 3, 2, 0, 0, 0, 0, 0, —2, 1, 2, 2, 0, 0, 0, 1, 3, 0, 0, 1, —1, 1, 1, 0, 0, 1, 0, 1, 0, —1, 0, 4, —1, 2, 0, 1, 0, 0, —1, 2 = 83.

May 6. 3, 2, —2, 0, 0, 0, —2, 0, 0, 0, —1, 3, 0, 0, —2, 1, 3, 0, 0, 1, 0, 1, 0, 0, 0, 2, 1, —2, 2, 1, 0, 1, 4, 1, 0, 1, 0, 1, 0, 0, 2, 0, 0, 1, 2, 0, 2, 2, 1, 3, —1, —1, 0, 1, 0, 0, 1, —2, —2, 3, 1, 1, 3, —1, 4, 2, 0, 2, 1, —2, 0, 0, 1, 0, —1, 2, —2, 1, 2, 0, 0, —1, 0, 0, 0, 0, 0, 0, 2, 1, —1, 2, —2, 0, 1, 1, 3, 0, 0, 1, —3 = 105.

May 7. 1, 1, 1, 0, 0, —1, —2, 0, 0, 0, —3, 0, 1, 0, 0, 0, 0, —1, 0, —1, —1, 2, 1, —1, —3, 0, —2, 0, 0, 0, 0, 2, 0, 0, 0, 2, 0, 0, —1, 0, —2, 0, 2, 0, 0, —2, 0, 0, 0, —1, 0, —1, —1, 0, —1, 0, 0, —2, 0, 2, 0, 0, 0, 0, 0, —1, —1, —1, 3, 0, —1, 0, 0, 0, 0, —1, 1, 0, 2, —2, 0, 1, 0, 0, 1, 0, —2, 0, —2, —1, 0, 0, 0, —1, 0, —1, 0 = 64.

May 8. 2, 0, 1, 0, 0, 0, —1, —2, 3, 0, 0, 0, —1, 2, —1, 2, 0, 3, 0, 1, 2, 3, —2, 1, 1, 0, 0, —1, 0, —4, 0, 0, 0, —1, —1, —1, —1, 0, 0, —1, —1, 0, 0, —2, 0, —1, 0, —1, 2, 2, 0, 2, —2, 0, —1, 2, 0, 0, 1, 0, 1, 1, 0, 2, 0, 0, 1, 0, —1, 0, 0,

TABLE VIII
(*Continued*)

Subject—D.

Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

3, 0, —2, —2, 0, 0, 0, 0, —2, —1, 4, 0, 0, 3, 0, 0, 0, 0, 0, 0, —1, —1, 0, 0, 0, 3, —2, 1, 0 = 86.

May 9. 4, 2, —1, 0, —1, —1, —1, —1, 0, —2, 1, —1, 0, —1, 0, 2, 2, 0, 2, 0, 0, 0, 0, 0, 2, 0, 0, 3, 1, 0, 0, 1, 0, 1, 0, 1, —2, —1, —1, —1, 2, 1, 1, 0, 0, 1, —1, 0, 0, —1, 2, 0, 2, 2, 0, 4, 0, 0, 0, —1, 0, 0, 0, 0, 2, 0, 2, 0, 1, 1, 0, 4, 0, 0, 0, 2, 0, 4, 0, 1, 0, —1, 0, 0, 0, 0, 1, —1, 0, 0, 0, 3, 1, 0, 1, 0, 1, 1, 0, 0 = 81.

May 10. 3, 0, —1, 2, —1, 0, 0, 2, 2, 2, —1, 2, 0, —3, 2, 0, 0, —1, 0, 0, —1, 0, 0, 0, 0, 0, 3, 0, —1, 0, 0, —1, —2, 2, 0, 0, 2, —1, 1, —1, 0, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0, 0, —1, 0, 0, 0, 0, 1, —1, 1, 1, 0, 0, 1, 0, 3, 0, 2, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 2, 3, 0, 0, —4, —1, 2, —1, 0, 0, 0, —1, 1 = 66.

May 11. 1, 0, 0, —1, 0, 0, 0, 2, 1, 2, 1, —1, 0, 0, 3, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 2, 2, 0, —1, 1, 0, —1, 0, 0, —2, 2, 2, —1, 0, 0, —2, 0, 0, —2, 0, 0, 0, 1, 0, 0, 2, —1, 0, 0, —1, —1, 0, 0, 2, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 2, 2, 1, —3, —2, —1, 0, —2, 2, 0, 0, 0, 1, 2, 0, 0, 0, 0, 0, 0, 1 = 64.

May 12. 0, 1, 0, 1, 0, 0, 3, 0, 1, 2, 0, 0, 2, 0, 0, 0, 0, —1, —2, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, —1, 0, 2, 0, —1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, —2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, —2, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, —2, 0, 0, 0, 0, 0, 0, 0, 0 = 35.

May 13. 0, 0, —1, 0, 0, 0, 2, 0, 1, 3, 2, 1, 0, 2, —1, 0, —1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, —1, —1, 0, 0, 0, 1, 0, —1, 1, 0, 0, 0, 0, —1, 1, 0, 0, —1, 0, —1, 0, 0, 1, 2, —1, —1, —1, 0, —1, —1, 1, 1, 0 = 46.

May 14. 1, 0, 0, 1, 0, —1, —1, 0, 0, —3, 0, 1, 1, 0, 0, 1, —1, 0, 0, 0, 0, 2, 0, 0, —1, 1, 2, 0, 0, 1, 2, 0, 0, 1, 1, 0 0, 0, 0, 0, 0, —1, —1, 0, 2, 0, —1, 1, 0, 1, 1, —1, 3, 0, 1, 1, 2, 0, 0, 1, —1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 2, 0, 0, 0, 0, 1, —1, —3, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 5, 0, 0, 0, 1, 0, 1, 0, 0 = 58.

May 15. 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 2, 1, 2, —1, —1, 0, 0, 0, 1, 1, 1, 1, 1, —1, 2, 1, —1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0 0, 0, 1, 0, 0, 0, 0, 0, 1, 2, 0, 0, 0, 0, 0, 1, 3, 1, 3, 0 0, 1, 1, 4, 1, —1, —2, 0, 0, —1, 0, 0, 0, 0, 1, 0, 2, 2, 2, 0, 0, 0, 1, 0, 2, 0, 0, —2, —2, 0, 1, 0, 2, 1, 0, 0, 0, 0, 0, —2, —1, 0 = 65.

May 16. 1, 0, 0, 0, 1, —2, 3, 4, 2, —2, 0, 1, —2, 0, 1, 2, 1, 0, 4, 1, 0, 0, 0, 2, 1, 2, 0, 0, —1, —2, 1, 3, 0, 2, 0, 0, 1, 0, 2, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, —1, 1, 0, 0, 1, 3, 1, —1, —1, 2, —1, 0, 0, 1, 1, 1, 1, 1, 0, 1, —1, 1, 0, —1, 2, 0, 0, 2, 0, 2, 0, —1, 0, 0, 0, 0, —1, 0, 1, 3, 0, —1, 0, 2, 1, 3 = 89.

May 17. 0, 0, 1, 2, 0, 0, 0, 0, —1, 0, 1, 0, 2, 3, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, —1, 0, 1, —1, 0, 1, 0, 0, —1, 0, 0, 0, 2, 0, 0, 0, —1, —1, —1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, —1, 0, 0, 0, 0, 0, 1, 0 = 35.

May 18. 2, 2, 0, 0, 0, —1, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,

TABLE VIII

Subject—D.
Experiment—To obtain a curve of learning for direction. Work consisted in rolling a steel ball at a mark.

0, 3, 0, 0, 2, 0, 0, 0, 2, 1, 0, 0, 0, —1, 0, 0, 0, —1, 0, 0, 2, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, —1, 1, —1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, —1, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 = 41.

May 19. 1, 1, 1, 0, —1, 0, 0, —1, 0, 0, 0, —2, —1, 0, 0, 0, 0, 1, 0, 0, —1, 1, 2, 0, 0, 1, 0, 0, 0, 0, 0, —1, —1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 2, 2, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 2, 0, 0, 1, 0, 0, 1, 0, —2, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0 = 38.

May 21. —2, —1, 0, 0, 0, —1, —2, 0, 0, 1, 0, —1, 0, 0, 3, 1, 1, 0, 0, 0, 0, 0, 0, 0, —1, 1, 2, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —1, 0, 0, 0, —1, 1, 0, 0, 0, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, —1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —1, 1, 0, 0 = 32.

May 22. 0, 2, 0, 3, 0, 0, 0, 1, 0, 1, 0, —1, 0, 0, 0, 1, 1, 2, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, —1, 0, 1, —2, 0, 0, 0, 1, 0, 4, 0, 0, 0, —1, —2, 0, 1, 0, 0, —2, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, —1, —1, 0, 1, 0, 0, 0, —1, 0, 0, —1, 0, 0 = 40

Curves XVI and XVII (Plate IV) are obtained by letting the total score for each day's practice represent divisions on the y-axis and practice periods represent divisions on the x-axis.

Curves were also plotted representing the improvement measured in terms of actual hits. The total number of hits made in each day's practice was taken as a basis for divisions on the y-axis and the number of practice periods as the basis for divisions on the x-axis. Curve XVIa (Plate VIII) shows the typical form.

The two subjects were very different in their manner of throwing. Subject W., after a few days practice, threw the steel ball so that it curved from right to left. He used only enough force to enable the ball to reach the mark. He aimed at a mark on the board about eight inches from where he released the ball. After he had this plan perfected, it made no difference if a piece of card-board was set up between him and the block of wood in such a way as to shut off the view entirely.

Subject D. threw directly at the mark. The ball rolled straight for the most part and with considerable force. Notwithstanding the difference in their method of practice, the curves show considerable similarity in the form of the improvement. Although

the daily fluctuations are quite large, there is an almost constant downward course to each curve. The large fluctuations from the thirteenth to the twenty-first practice of Curve XVI represent the period when the subject was attempting to curve the ball and to locate a place on the board near his hand through which he could throw the ball. It will be noted that at only one place are there as many as four consecutive points on the same side of the line passed from point seventy on the y-axis to point thirty-six on the x-axis of Curve XVI. With the exception of the period when the subject was attempting to find a new method, the curve follows the general direction of this line. The average deviation of the points from this line is eight. The upper heavy line shows the position where the plus and minus deviations are balanced. The sum of the deviations above this line is equal to the sum of the deviations below the line. The two dotted lines show the average deviation from the line.

The course of Curve XVII is fairly well shown by a line drawn from 135 on the y-axis to a point 37 units above 35 on the x-axis. There is a period from the thirteenth to the twentieth practice when the score was rather high which was the result of the subject trying to spin the ball on its axis. The only explanation for the rise at the thirtieth and thirty-first practices was the bad weather which may have affected the subject. Only in one case here do as many as four consecutive points remain on the same side of the line and three of these are within the average deviation limit, which is twelve in this case and is represented by the two dotted lines.

An examination of Tables VII and VIII shows that the subjects were able to do almost equally well in each half of a practice period. The scores that Subject W. made in the first half of his daily practices were as follows:

50, 33, 31, 20, 24, 24, 44, 31, 22, 19, 27, 19, 22, 37, 31, 19, 17, 25, 28, 30, 13, 9, 12, 24, 12, 16, 20, 6, 11, 1, 4, 4, 12, 8, 9, 5. Total 619.

The scores for the last half of each practice were:

40, 30, 42, 24, 25, 23, 21, 21, 26, 27, 29, 24, 29, 28, 26, 25, 15, 21, 28, 12, 17, 4, 6, 4, 2, 6, 16, 10, 2, 4, 5, 5, 0, 1, 1, 2, 7. Total 608.

The scores for the first half of each practice for Subject D. were:

33, 79, 63, 71, 48, 71, 49, 67, 53, 49, 58, 47, 58, 64, 38, 56, 55, 39, 51, 34, 47, 43, 38, 32, 22, 21, 28, 25, 46, 18, 24, 24, 23, 22, Total 1496.

The scores for the last half of each practice were:

71, 46, 59, 71, 47, 51, 47, 57, 49, 35, 49, 37, 57, 46, 41, 44, 51, 61, 44, 54, 30, 39, 38, 28, 32, 13, 25, 30, 40, 43, 17, 17, 14, 9, 18. Total 1410.

On July 17, 1914 Subject W. was tested again in this work. The only difference was that the board this time was covered with heavy paper. He had had no practice since May 18, 1913. This practice consisted of a hundred trials. The result was:

First fifty. —1, 4, 5, 4, 7, 0, 0, 0, 3, 0, 1, 0, 6, 3, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 3, 0, 1, 0, —2, 0, —2, 1, 2, 0, 0, 0, 4, 0, 0, 1, 0, 0, 0, 0. Total 52.

Second fifty. 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 5, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 5, 0, 0, 0, 0, 0, 4, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Total 16.

The subject explained his difficulty in the beginning by the fact that the ball would not curve on the paper as it had done on the board. The second fifty shows how fast he was able to adapt his method to the covered board and then his work was nearly as good as it had been at the end of the practice.

In order to give an idea of the amount of skill that had been acquired by the above subject a comparison practice was given Subject Do. (Dockeray) on the same day as the above practice and the following score was made:

2, 0, 6, 0, 5, —2, —4, 1, 0, 5, 4, 2, 0, 4, 3, 1, 1, 3, 5, 6, 0, —5, —6, 7, 1, —5, 6, 5, —1, 1, —7, —2, 0, 5, 6, 5, —1, 1, —7, —2, 0, 5, 6, 5, —1, 1, —1, —2, 1, 5. Total 154.

This is a considerably higher score than either of the other two subjects made in their first practice but it indicates that the putting on of the paper had not made the work easier.

Experiment II. On Force

Four subjects took part in this experiment: Subject W. (Wang), Subject D. (Decamp), Subject C. (Cole), and Subject Do. (Dockeray). The last two were also graduate students

in psychology. The apparatus for Subject W. was the same as in the preceding experiment, except the block of wood was not used and instead of the steel ball, two rubber balls that had been used in the ball tossing experiments were used. The board was placed on a table with a point marked zero three and one half inches above the mark from which the ball was thrown. There was a space of seven and one half feet on the board between these two marks. At the zero mark a heavy line was drawn across the board. On either side of this line divisions were laid off three inches wide by other lines drawn across the board parallel to the line running through the zero mark. These divisions ran up to plus thirteen on one side of the zero mark and to minus thirteen on the other side of the zero mark. The mark from which the ball was thrown was drawn across the board parallel to the line drawn through the zero mark and was, as stated above, seven and one half feet from it.

The second board which was used with the other three subjects was covered with a piece of heavy paper during the latter part of the practice. It was laid off in the same way as the one above except the divisions ran up to plus fifteen on one side and to minus fifteen on the other side. The minus numbers in both cases were next to the subject. In this case the steel ball was used instead of the rubber balls.

The subject in both cases stood at the lower mark and attempted to throw the ball so that it would roll to the zero mark. He was instructed not to let his hand pass the lower mark. The subjects that shot the steel ball as one would a marble with the thumb put the fore finger down on the mark and did not move it when the ball was released. If the ball went beyond the zero mark the division in which it stopped was noted as "+8" etc., or if it did not reach the zero mark the division was indicated as "—7" etc.

The results of this experiment are shown in Tables IX, X, XI, and XII. The first horizontal column of figures shows the days on which the practices were taken. The first vertical column represents the divisions on the board. The columns to the right of this show the distribution of each fifty throws. Commencing

at the top of the first practice period (Feb. 1) of Subject W., it is seen that the ball stopped twice in the plus thirteen division, twice in the plus eleven division, etc. The score is found by multiplying the numbers in the first vertical column by the numbers that stand opposite to them in the practice columns and taking the sums of these products.

Subject W. commenced work on Feb. 1, 1913 and continued until Feb. 20, 1913. Subjects D. and Do. commenced on June 29, 1914 and Subject C. on June 30, 1914. All three of these subjects continued practice until July 19, 1914.

In this work, Subject W. and Subject C. used a full swing of the arm to throw the ball. Subject D. and Subject Do. used only the thumb to propel the ball. The curves for these results are plotted by using the number of spaces that the mark is missed for the divisions on the y-axis and the practice periods for the divisions on the x-axis. Curves XVIII, XIX (Plate V), XX, and XXI (Plate VI) show the general trend of this learning. Curves XVIII and XIX show a marked drop at first and then a more gradual fall with wide fluctuations. Curve XX shows a relatively low score during the third and fourth practices and then a rise which lasted for several days. This was caused by putting paper on the board which made the ball roll more easily. It appeared to bother this subject much more than the others. On the twelfth day he found that he could judge the force much better when he let his finger drag along lightly on the paper. After that his score continued to be much lower.

The curves may be compared by passing a line through them so as to leave as nearly as possible the same number of points on either side of the line and at the same time have as few consecutive points on either side of the line as possible. In Curve XVIII, a line drawn from ninety on the y-axis to a point seventy units above the twenty one on the x-axis leaves ten points on either side of it with not more than three consecutive points in one place. The sum of the deviations of the plus units is 115+ and that of the minus units is 102+. The average deviation from this line is 10.9 and is represented by the dotted lines.

In Curve XIX, a line drawn from one hundred and eighteen

TABLE IX

Subject W.

Experiment—To obtain a curve of learning for force. The first horizontal column shows the days on which the trials were made. The first column to the left represents the divisions on the board. The columns to the right of this show the result of each fifty throws. The number at the foot of each vertical column shows the total score.

Feb.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
13	2	1																		
12		1		1	2															
11	2	2	1	1									1						1	
10	2	1	2				1	2		1							1	1		
9	6	1		1			2	2			2							1		
8	3		1		2	3	1	1	1		2	2		1		1		1		1
7	5	2	1	1	2	1	2	1	1		3	2	1				1		1	
6	2		1	2	2		1	1	1	2	2	1	3	3	2	2	3	2	1	1
5		1	1	2	3	1	2	1	1		2	3	1	2	1		4	1	4	2
4	5	3	4	3	2	2	4	3		5	5		2	1	2	1	3	2	1	2
3	2	3	3	3		2	7	3	6	7	2	4	2	5	9	3	6	4	3	1
2	1	2	3	3	1	3		4	4	6		6	4	3	5	7	3	3	5	3
1	3	4	3	3	2	1	3		6	3	4		10	3	4	4	1	7	3	2
0	1	2		2	4	2	1	3	4	1	3	1	2	3	1	2	2	2	1	1
— 1	4	3	7	3	2	8	2	6	2	3	1	2	2	9	5	7	3	5	2	5
— 2		2	5	5	7	4	2	4	4	5	8	4	5	5	4	3	3	7	5	5
— 3	1	3		3	3	6	4	4	7	2	4	4	4	3	4	1	3	2	6	5
— 4	1	2	5	2	4	7	6	4	5	4	1	5	3	4	3	3	3	6	9	7
— 5	1	2	3	4	4	5	3	3	5	3	6	6	6	3	2	5	1	3	3	4
— 6		4	5	4	2	2	5	2	1	3	2	2	1	2	3	10	4		2	7
— 7	1	5	2	2	4			3	1	2	2	4	1	1	4	1	6	1	1	1
— 8		3	1	1	2	2	2			1	1		1	1	1					3
— 9			1	2	2		1	1	1	1		3					1			
—10		1	1	2				2					1				1		1	
—11										1							1		1	
—12		1					1					1		1						
—13	8	1				1														
	351	266	214	225	228	185	230	202	156	188	204	226	170	162	167	171	223	148	191	194

TABLE X

Subject D.

Experiment—To obtain a curve of learning for force. The first horizontal column shows the days on which the practice was made. The first vertical column to the left represents the divisions on the board. The columns to the right of this show the result of each fifty throws. The number at the foot of each vertical column shows the total score.

June		July																				
	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
15	7	5	1	1	1				1	1	1							1		1	
14			2		1																
13	3	1				1	1	1			1	1			1		1				
12	1		2		2	1			1	1			1								
11	1	1	2	1						1	1								1		
10	1	1		1										1		2		1	1	3	3
9	3	2		3	4		2			2	3	1		1	3	1			1		4
8		1	2		2	3	3	1	1	2	2	2	1	1				2	2	2	2
7	1		2	1		4	1	3				2	1			1	2	1	1		1
6	7	1	2	3	2	2	1	2	1	1	1	4	1		4	1	3		1	2	2
5	3	2		3	3	3	5	1	4	1		2	3	2	1	5	1	1	2	5	2
4	1	2	1	4	5	4	4	2	3	2	4	1	1	1	1	4	4		1		2
3	3	2		2	5	8	7	7	6	4	2	2	5	4	2	1	5	5	4	4	4
2	2	1	4	3	1	5	6	5		2	2	2	2	2	3	2	7	5	3	3	7
1	1	3	4	2	5	2	2	2	2	1	5	2	3	4	6	6	5	4	5	4	4
0	2	3	3	5	2	5	3	4	2	4	3	8	6	8	8	4	5	6	4	4	1
— 1	2	2	2	7	4	2		2	4	5	3	4	2	5	4	6	4	8	8	2	2
— 2		2	4	1	1	2	3	3	4	5	4	2	3	4	3	2		5	3	4	1
— 3	4	3		3	2	2	3	7	3	2	2	4	4	2	6	3	3	2	2	4	1
— 4	1	3	6	2	1		4	3	2	4	4	2	5	3	4	4	3			2	5
— 5			1	1	1	1	1	2	3	2	2		5	2		1	2	2		3	1
— 6	1	3	3	3	1	1	2	2	2	2	4	2	3	4		1	1	4	5	1	1
— 7		2		3	2		1	2	1	2	2	3	1		1				1	2	3
— 8		4	3		1	1		1	2	2	1	5	1		1				3	1	2
— 9	1	1		1		1							1	1		2	2		1		1
—10			1						3	1				2	1	2				1	
—11	1	2				1			1				1	2		1					
—12			2		1	1	1			1									1		
—13	1	1	2						4		1	1						1		1	1
—14					2						1						1	2			
—15	3	2	1		1					2	1				1	1	1			1	
	388	335	303	212	278	219	211	185	265	249	250	216	192	184	175	206	188	181	198	231	246

TABLE XI

Subject C.

Experiment—To obtain a curve of learning for force. The first horizontal column shows the days on which the trials were made. The first vertical column to the left represents the divisions on the board. The columns to the right of this show the result of each fifty throws.

June	July																			
	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
15	3	8	1	2		3	2	1	3				1							
14		1			1					1										
13				1	1					1										
12	4				1	1	3	2			1									1
11	4			1	2	1	2	1				1		1						
10		1	1		1		1		2	1	2	1	1						1	
9	2	2	1	1	1		1	2	3	2	3	3		1		1	2			
8	3	2		2	6	3	2	1	1	2		1	2					1		
7	3	2		1	3	2		1	2	3	2	1	1	1				1	1	2
6	1	1	1		2	1		1	1		3	4	1		2	2	3		1	1
5		2	4	1	1	2	4	1	2	2	2	1		3	4	3	1	2	6	3
4	2		5	1	3	4	3	2	1	3	2	2	2	3	3	3	3	2	2	4
3	3	5	4	2	3	3	3	2	3	2	4	7	3	2	2	4	2		3	5
2	2	4	3	9	3	1	2	5	4		3	4	9	4	6	4	2	5	5	2
1	5	2	2	7	3	3	3	4	5	3	4	3	5	9	4	3	5	5	8	4
0	6	4	5	2	2	6	2	2	7	5	6	7	5	6	10	11	9	14	3	8
— 1	1	3	5	1	4	3	1	1	3	5	2		5	3	6	3	6	6	6	8
— 2	2	1	4	6	3	2	2	4	2	3	2	4	7	3	4	5	7	4	2	3
— 3	2	5	4	2	2	4	5	2	1	3	1	2	3	4	2	5	4	3	2	5
— 4	1	1	2	5	2	2	3	5	4	4	2	2	2	2	3	1	2	4	4	1
— 5	2		2	4		5	7	3	1	3	2		2	2	2	1	2	2	2	1
— 6	1	1	2			2		3	1	1	1	3		2	2	3		1	3	1
— 7		1	2	1	2	1	1	1	1	2	3	2	1	2		1	1			
— 8	1	1	1		1		1	3		2	2								1	
— 9		1		1	1		1		2	1		1					1			1
—10									1	1	1	1		1						
—11	1							1			1									
—12						1														
—13		1			1			2			1			1						
—14	1																			
—15		1	1				1													
	296	312	192	201	264	235	277	258	228	229	235	205	147	165	120	133	134	103	157	139

TABLE XII

Subject Do.

Experiment—To obtain a curve of learning for force. The first horizontal column shows the days on which the trials were made. The first vertical column to the left represents the divisions on the board. The columns to the right of this show the result of each fifty throws. The number at the foot of each vertical column shows the total score.

	June		July																			
	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
15							2														
14	1																				
13																					
12		1	1				1														
11																					
10		1				1	2														1
9	4			1	2	3	1	1		1				1							
8		1		3		2		1		3				1		1			1		
7	1			1		1	2	2	1	2	3							2			2
6	2	1	1	1	1	1		5	1		3	1	1	1	1	1		1	2	3	2
5	2	4	1	1	3	6	1	3	3	3	4			4	2	2	1	2	1	2	1
4	2	3	2	5	4	5	1		1	2	3	5	5	2	3	5	4	5	4	1	2
3	2		2	7	3	4	2	5	6	3	4	8	5	5	4	2	3	6	1	4	3
2	6	5	5	3	7	2	7	4	4	7	6	2	7	1	6	5	8	4	2	5	5
1	2	1	5	4	5	4		6	8	1	4	5	8	6	7	9	8	6	7	9	7
0	4	3	3	4	4	7	5	3	8	9	2	3	7	10	4	3	11	5	13	6	5
— 1	5	4	8	3	1	3	4	1	5	4	3	7	5	4	5	3	3	3	7	6	7
— 2	2		9	3	6	1	3	6	4	5	4	8	1	6	3	3	4	5	2	5	7
— 3	3	6	5	4	4		3	5	3	5	4	3	2	3	6	5	2	7	4	5	2
— 4	2	5	2	1	6	1	2	3	1	1	1	2	2	2	3	3	2	2	1	2	4
— 5	5	1	1	4			3	2			5	1		2		3	1				1
— 6	1	4	2	1	1	2	4		2				2	2	2	2		2	2		1
— 7		2	1	2	2	3	3		1		1		1		3	2			1	1	
— 8	1	2		1	1	1		2	2		1	2	2			1	2				
— 9		2		1			1			1		1	1							1	
—10	1	1	1				1				1	2	1								
—11		2				1				3									1		
—12	2	1	1			1	1				1				1						
—13	1																				
—14						1													1		
—15	1							1									1				
	234	242	147	184	160	223	232	186	127	169	188	149	138	129	145	154	115	136	126	119	130

on the y-axis to a point sixty eight units above twenty one on the x-axis leaves eleven points above and ten below with not more than four consecutive points on either side. The sum of the plus deviations is 144+ and the sum of the minus deviations is 131+. The average deviation is 13.3.

Curve XX does not yield to this method of treatment very well, partly for the reason mentioned in the preceding page. No line can be drawn through the curve in such a way as not to leave several consecutive points on one side. A line drawn as indicated from one hundred and twenty on the y-axis to forty units above twenty one on the x-axis shows its general direction about as well as any one line will do. This line leaves ten points above and ten below. The sum of the plus deviations is 111+ and the sum of the minus deviations is 109+. The average deviation is 11.

The direction of Curve XXI is indicated by a line drawn from eighty three on the y-axis to a point forty eight units above twenty one on the x-axis. This line leaves ten points above and eleven below. There are not more than three consecutive points on either side. The sum of the plus deviations is 84+ and the sum of the minus deviations is 88+. The average deviation is 8.6.

If the slope of the line is taken to represent the improvement it is seen that Curve XX stands first with a slope of .80. Curves XIX, XXI, and XVIII have respectively .50, .35, and .20.

For the purpose of comparison curves were drawn which represented a range of +1 to —1 on the board. For instance in Table IX on the first trial the ball stopped eight times on +1, 0, and —1. The sum of these three divisions was taken each trial for divisions on the y-axis and the number of trials for divisions on the x-axis. Curves XXa and XXIa show the general form of the curves obtained by this method.

It would seem in this experiment that the person who is able to make a low score would be the one who is able to perceive accurately small amounts of force. It would require the same kind of ability as distinguishing small differences in weights. In order to test this, three subjects (Subjects D., Do., and C.)

were tested for their ability to distinguish small differences in the weights of bodies. Eight weights were used for the test. Hollow hard rubber cylinders were used for this purpose and loaded with shot and felt so that they weighed 75.001, 76.004 77.002, 78.001, 78.996, 79.998, 85.004, 90.005 grams respectively. The weights were numbered from one to eight. They were presented to the subjects in pairs. The subject was blindfolded and required to lift the cylinders two inches from the table or until they touched a rod running horizontally. The subject reported the last weight as heavier or lighter.

The tables below show the result of the test:

Weights in order	1—8	1—7	1—6	1—5	1—4	1—3	1—2
Subject C. —Right.....	10	9	10	10	10	9	6
—Wrong		1				1	4

Weights in order	8—1	7—1	6—1	5—1	4—1	3—1	2—1
Subject C. —Right.....	10	9	8	5	4	4	5
—Wrong		1	2	5	6	6	5

This shows that the subject gave 109 right judgments and 31 wrong ones or he obtained a percentage of 77.8 correct.

Weights in order	1—8	1—7	1—6	1—5	1—4	1—3	1—2
Subject Do. —Right.....	10	9	5	10	7	8	7
—Wrong		1	5		3	2	3

Weights in order	8—1	7—1	6—1	5—1	4—1	3—1	2—1
Subject Do. —Right.....	8	8	8	8	7	6	6
—Wrong	2	2	2	2	3	4	4

This shows that the subject gave 107 right judgments and 33 wrong ones or he obtained a percentage of 76.4 correct.

Weights in order	1—8	1—7	1—6	1—5	1—4	1—3	1—2
Subject D. —Right.....	10	8	7	9	9	9	6
—Wrong		2	3	1	1	1	4

Weights in order	8—1	7—1	6—1	5—1	4—1	3—1	2—1
Subject D. —Right.....	10	8	7	2	3	5	4
—Wrong		2	3	8	7	5	6

This shows that the subject made 97 right judgments and 43 wrong ones or he obtained a percentage of 69. correct.

If these figures are compared with those representing the slope of the lines on the curves, it is seen that the subject that showed the greatest improvement in the force test has the largest percentage of correct judgments of weight and that the other two follow in order.

Experiment III. On Time

Subjects W., B., C., and D. took part in this experiment. The apparatus consisted of a circular piece of board about twelve inches in diameter and three quarters of an inch thick, placed in a vertical plane on an axis. Beneath the board was a pulley so that a motor could be attached and the board rotated. Two circular bands of cardboard were made by bending strips into the form of a hoop. These two bands were placed on the board, the one inside of the other. The inner band was one and one half inches in height and nine and five eights inches in diameter. The outer band was one and one half inches outside of the inner band and was one half inch high. The space between the two bands of cardboard was divided into twelve parts by tacking pieces of tin on the radii of the circular board. These pieces of tin were the same height as the outside band of cardboard.

A trough about twenty inches long was supported so that the lower end rested one half inch above the little pockets on the circular board. The other end of the trough was six and one half inches higher. The trough was made by nailing two pieces of wood together at right angles and then it was lined with soft tin so that it was perfectly smooth. A mark was made in the trough eighteen inches from the lower end. On this mark the subject held a piece of wood that fit the bottom of the trough and behind this was placed an ordinary B.B. shot. When the subject lifted the piece of wood the shot rolled down the trough and fell into one of the pockets on the circular board.

One of these pockets was marked by placing a piece of green paper in the bottom of it. The circular board was covered with a piece of cardboard from which a sector had been cut so that only a small part of the circular board was visible beneath the end of the trough. As the board rotated, the subject could see the pockets pass under the end of the trough and then disappear under the cardboard. The object was to release the shot so that they would roll down the trough in time to fall into the marked pocket. The circular board was rotated forty six times per

minute or a pocket passed the end of the trough in one ninth of a second. The movement of the board made it impossible to distinguish any of the pockets except the one that had the green paper in it. The subject waited a short time after the marked pocket had passed the end of the trough and then released the shot. The aim was to improve his ability to judge this period of time.

The subject could see the shot hit the pocket if they hit near the middle but if they hit near the side of the pocket he was not able to tell if they hit too early or too late. The pockets were marked zero, one, minus one etc. out in either direction. The score was kept by counting the number of shot in each pocket. These numbers were multiplied by the number of the pocket and then the sum of these products taken for the daily score.

Subject W. commenced this work on May 13, 1913 and continued it until May 24, 1913. The practice consisted of fifty trials daily. The result of his work is shown in Table XIII.

Subjects B., C., and D. commenced work on June 30, 1914 and continued until July 19, 1914. The practice was daily and consisted of fifty trials. The results are shown in Tables XIV, XV, and XVI.

Curves XXII, XXIII (Plate IV), XXIV and XXV (Plate VI) show the form of the improvement. All the curves show rather a large drop during the first two or three practices.. After that there is a slow but gradual improvement to the end of the practice. The first large drop in each case is the result of the subject's learning the apparatus. He would have a few very bad results at first which would not occur again after a few trials. Curve XXIII does not show this first early drop to so great an extent because the subject had set up the apparatus and knew by a few trials previous to the first test what to expect.

The direction of these curves after the first two or three practices is shown by the straight lines drawn through them. A line run from forty one on the y-axis to seventeen units above thirteen on the x-axis of Curve XXII shows that with the exception of the first two practices the points alternate on either side of the line. The sum of the plus deviations is 10 and the

sum of the minus deviations is 15. The average deviation is 2.5.

On Curve XXIII, a line run from thirty five on the y-axis to fifteen units above twenty one on the x-axis leaves not more than two consecutive points on either side. Omitting the first practice, the sum of the plus deviations is 35 and the sum of the minus deviations is 36. The average deviation is 3.5.

On Curve XXIV, a line run from forty three on the y-axis to twenty nine units above twenty one on the x-axis leaves no more than two consecutive points on either side of the line. The sum of the plus deviations is 29.4 and the sum of the minus deviations is 33. The average deviation is 3.2.

On Curve XXV, a line run from thirty four on the y-axis to a point eighteen units above twenty one on the x-axis leaves no more than three consecutive points on the same side of the line. The sum of the plus deviations omitting the first one, is 41.8 and the sum of the minus deviations is 41.7. The average deviation is 4.1. The slope of these lines is .40, .20, .14 and .16 for the curves taken in order.

When the actual number of hits, that is the number of shot that went into the marked pocket was taken to represent divisions on the y-axis and the trials to represent divisions on the x-axis, the curves take the form represented by Curves XXIVa and XXVa (Plate VII).

TABLE XIII

Subject W.

Experiment—To obtain a curve for learning to judge time. The first horizontal column represents the number of practice days. The first vertical column to the left shows the number of the pockets. The other vertical columns to the right show the distribution of the fifty shot in each practice. The number at the foot of each vertical column shows the total score.

May	13	14	15	16	17	18	19	20	21	22	23	24
5	1	1										
4	0	1										
3	2											
2	6	7	5	1	5	1		1	3			
1	6	6	13	14	8	15	18	8	13	10	13	8
0	12	17	18	23	27	22	18	25	28	26	33	30
— 1	10	10	13	10	7	12	13	15	6	12	3	12
— 2	4	4	1	1	3		1	1		2	1	
— 3	6	4		1								
— 4	2											
— 5	1											
— 6												
	78	59	38	31	34	29	33	27	19	26	18	20

TABLE XIV

Subject B.

Experiment—To obtain a curve for learning to judge time. The first horizontal column represents the number of practice days. The first vertical column to the left shows the number of the pockets. The other vertical columns show the distribution of the fifty shot in each practice. The number at the foot of each vertical column shows the total score.

	June 30	July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5																					
4	3				1																
3	2	1	1									1					2				
2	9	2	1		3	5		2	2	2	1		1			1	1				2
1	8	19	20	11	14	13	15	12	14	13	14	10	10	17	16	12	12	13	10	8	6
0	17	18	22	28	18	20	28	28	27	26	25	30	33	27	29	30	28	34	31	40	34
— 1	9	10	6	10	13	9	6	8	7	9	10	8	6	6	5	7	6	3	9	2	8
— 2	2				1	3	1					1					1				
— 3				1																	
— 4																					
— 5																					
— 6																					
	57	36	31	24	39	38	23	24	25	26	26	23	18	23	21	21	28	16	19	10	18

TABLE XV

Subject C.

Experiment—To obtain a curve for learning to judge time. The first horizontal column represents the number of practice days. The first vertical column to the left shows the number of the pockets. The other vertical columns to the right of this show the distribution of the fifty shot in each practice. The number at the foot of each vertical column shows the total score.

	June 30	July 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
5		1					1													
4	3	2		1		1														
3	20	6	2		2		1				1	1					2			
2	20	27	8	7	3	5	5	1	4	5	1	1	5	4	4	1	5	2	2	1
1	4	8	17	17	6	17	7	13	17	18	15	16	15	20	15	14	5	11	16	13
0	1	4	15	16	30	16	26	24	20	19	22	19	19	20	17	25	26	25	22	24
— 1			5	8	8	11	6	10	8	7	9	12	11	6	11	10	10	10	10	12
— 2	1		2	1	1		4	1	1	1	2	1			3		2	2		
— 3		1	1																	
— 4	1							1												
— 5																				
— 6		1																		
	122	102	51	45	28	42	39	32	35	37	33	35	36	34	40	26	35	29	30	27

TABLE XVI

Subject D.

Experiment—To obtain a curve for learning to judge time. The first horizontal column represents the number of practice days. The first vertical column to the left shows the number of the pockets. The other vertical columns to the right of this show the distribution of the fifty shot in each practice. The number at the foot of each vertical column shows the total score.

	June	July																			
	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5	1																				
4	1																				
3	6	1																			
2	9	8	4	1	3	1	2					1	2	1	1	1					
1	10	12	18	13	12	17	13	17	11	9	10	18	6	7	12	15	9	7	8	18	12
0	9	22	23	22	24	19	23	21	28	32	28	21	33	33	31	22	30	30	38	22	28
— 1	7	4	5	13	11	11	10	12	11	8	12	9	8	9	6	12	10	11	4	10	10
— 2	3	3		1		2	2			1		1	1				1	2			
— 3	2																				
— 4																					
— 5	1																				
— 6	1																				
	85	41	31	30	29	34	31	29	22	19	22	31	20	18	20	29	21	22	12	28	22

An examination of all these curves where a single element is involved shows that there is a large degree of similarity in them. All three of the experiments were such that it was hardly possible to reach and maintain the limit of perfection. Except in the cases where the subjects made very high scores during the first two or three practices, the curves show a downward slope with considerable daily fluctuations. These daily fluctuations balance each other in almost every case within four or five days.

It is likely that if the practice had been continued until the subjects had reached a point where they were no longer able to distinguish the selective element as force or time, the curves would have approached parallelism with the x-axis.

In the ball tossing experiments the work was such that a number of elements had to be improved together or the unit of measure did not indicate the advance. In the second set of experiments where the elements of direction, force and time are involved a relatively simple reaction was required. The next set of experiments are such that a number of elements are involved but in such a way that the attention may be focused on any one of them or distributed over the whole of them.

THE EFFECT OF SEVERAL FACTORS WORKING IN SUCCESSION

The ball-tossing experiments showed the nature of the curves of learning when several factors must be attended simultaneously. The experiments on the judgment of direction, force, and time showed the form of the curves of improvement when the attention is centered on a single factor. It is the purpose of the following experiments to show what form the curves of learning take when several factors influence the attention but in such a way that they can be considered separately.

Four subjects—M. (Martin), Fe. (Feemster), S. (Miss Scott), Cd. (Miss Coldwell) took part in the work. They were all undergraduates in college.

The apparatus (See Fig. 1) consisted of a disk ten inches in diameter cut from a pine board three quarters of an inch thick. This disk was placed in a horizontal plane on an axis. The axis ran through and was fastened beneath a table. Beneath the disk was a pulley by which a motor could be attached. On top of the disk, eight holes had been scooped out similar in form to the bottom of a spoon. These holes were three quarters of an inch in length, one half of an inch wide and one fourth of an inch deep. They were located three quarters of an inch from the circumference of the disk and extended across the ends of four diameters that divided the disk into eight equal parts. A piece of cardboard covered three fourths of the disk leaving one fourth in the form of a sector exposed. The top of the disk was three inches from the table.

A frame was set up twenty-three inches from the center of the disk. This frame was perpendicular to the table and was in a plane parallel to the radius that divided the exposed sector of the disk into two equal parts. The frame was sixteen inches square and inclosed a hoop that just touched the sides. A piece of cloth was spread over this hoop and sewed to the hoop all

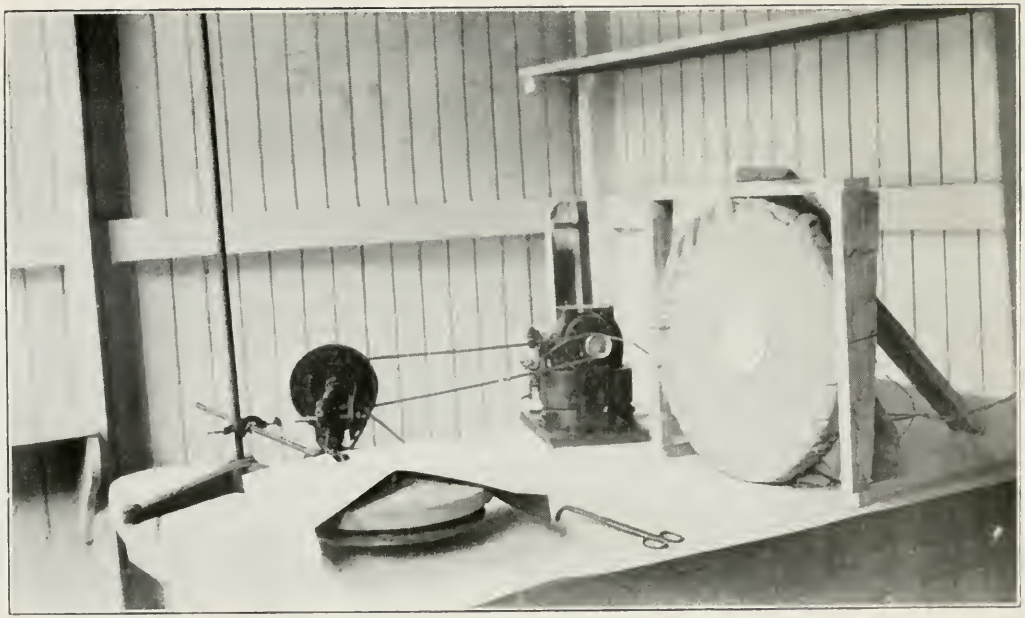

FIG. 1

the way around the border. At the center a circular piece of wire was inserted which was four inches in diameter. A piece of cloth was sewed to this wire ring in such a way as to leave a pocket extending out on the side opposite to the disk. The center of this pocket was eight inches from the table and about five inches above the level of the top of the disk.

The subject held in his right hand a pair of tongs nine inches long which were bent down at right angles one inch from the lower end. The seizing end of the tongs was one eighth of an inch wide and was ground perfectly smooth.

The work of the subjects was to take these tongs and seize shot from the eight holes on the disk and throw them into the four inch pocket in the middle of the circular hoop twenty-four inches to the right. The disk was rotated eleven times per minute by means of a motor. This made the shot pass the point where they were to be seized at the rate of eighty-eight per minute. After the subject had struck at the shot during one revolution of the disk, he rested until it was refilled. The subject was instructed to strike at every shot that appeared and to throw as many of those that he seized into the pocket as possible.

In taking the data, four things were considered: First, the hitting the shot; second, the seizing the shot; third, the hitting the large circle which included all of the area of the hoop which was sixteen inches in diameter; fourth, the hitting the pocket. The practice consisted of eighty strokes at shot, taken daily, except as noted in the tables. The practice of all the subjects was in the afternoon between twelve-thirty and one-thirty o'clock.

Subject M. commenced this work on Jan. 20, 1914 and continued it until June 5, 1914. He was given a certain position in which to stand, that is on a certain side of the table, and was told to strike at every shot as it appeared with the aim of seizing it and throwing it into the pocket. The importance of striking every shot was emphasized and at the end of eight strokes he was required to make a stroke at the hole in which he had struck at the first shot. This was done so that he could not take extra time to throw the last shot.

The result of his work is shown in Table XVII. Curve XXVI

(Plate V) is plotted from these figures. The spaces on the y-axis represent the number of shot. The spaces on the x-axis show the number of practice periods. The part at the top shows the number of shot hit; the next one below it, the number of shot seized; the third one, the number of shot that hit the big circle; and the fourth one, the number of shot that were thrown in the pocket. As nearly all of the shot that were seized were thrown so that they hit the big circle, the second and third parts run along almost together.

The subject's attention during the first two or three practices was almost entirely upon the disk. He was not able to take his eyes off the board long enough to look at the pocket and then return them in time to make a stroke at the next shot. He then tried to remember the general direction of the pocket. About the third practice, he felt that he was getting a better idea of this direction. He soon found that he had trouble handling the tongs. He would hit the shot but they would roll away from the end of the tongs. This trouble represents a period from the third up to about the fifteenth practice. The wide fluctuations on the sixteenth, seventeenth, eighteenth and nineteenth practices are the result of trouble with the motor. The belt slipped at first so that the disk rotated about one revolution per minute slower. After it was tightened the disk was unsteady in its motion so that the subject was not able to get hold of the shot.

It will be noted that very little progress had been made in the second and third parts during the time that the subject was having trouble with the tongs. The fourth part showed some slight improvement which was due to the subject's gaining a better idea of the general direction of the pocket.

The first part shows that the subject had trouble hitting the shot up to the fifty-first practice. About that time he commenced to watch the disk that carried the shot make one full revolution before he started to strike. He noted the exact position of every shot and, as he said, had a mental picture of just how it looked. It may be seen that parts two and three shortly after this, rise to a higher level. They had remained almost on the same level from the nineteenth to the sixtieth practice with

the exception of the marked drop between the thirty-fifth and the forty-second practices. Here the subject developed a habit of bringing the shot back with the return stroke of the tongs. This bothered him so that he was not able to grasp the next shot. He discovered the trouble to be due to having changed very slightly the angle of the tongs when releasing the shot. Instead of having the end that contained the shot point toward the pocket, he had been holding them so that the end pointed down toward the table. When he opened the tongs under this condition the quick back motion did not give the shot time to drop but carried it back.

During the time from the fifteenth to the fifty-seventh practice the fourth part shows practically no improvement. He had been trying to seize and throw all the shot without trying, directly, to improve the manner of locating the pocket. It may be noted that shortly after the first part had been perfected, the second and third also rose to a higher level. His concentrating his attention upon the position of the shot enabled him to seize them oftener.

This may in part account for the rise in the fourth part from the fifty-ninth to the sixty-third practice. But the subject during this time discovered another change. He at first noted that standing with his feet in a certain position gave him a certain balance that he did not have otherwise. He later found that when he stood with his feet in this position and stretched out his arm straight towards the pocket, the end of the tongs rested about one and one half inches from the center of the pocket. This was the position in which he could do the best work and after he had discovered this way of locating it he always stretched out his arm and took the proper position before starting.

There is not much improvement in any of the parts after this. The subject was very desirous of getting a perfect record even up to the end of the practice and thought he could do so if he had had a few more times to practice. He succeeded a few times in making as many as six rounds of the disk or seventy-two strokes without missing. This chance to see any variation in the progress gave an added incentive for greater effort. At the end of the practice, the subject was asked to write out the factors, as he remembered them, that helped him in the work.

He gave the following outline:

"Some factors that were important in this experiment:

1—Concentration of mind on the work before beginning.

a. Must have a clear conception of the apparatus in mind.

b. Must think of the actual work to be done.

c. Must think of the distance, direction, and position of the pocket as related to the revolving disk.

2—Getting the proper position.

a. Stand with the feet separted about two feet.

b. Stretch the hand that holds the tongs toward the pocket until the tips of the tongs are about one and one-half inches from the center of the pocket. Then look down the arm to see that the same relative position is gained each time. After this, move the hand back and forth as if throwing the shot to insure absolute freedom of the arm. Just before beginning, fix the eyes upon the revolving disk, and at the same time look out of the corner of the eye at the pocket. After the body is in a proper position, let the disk make one complete revolution. During this time look steadily at the shot to see that they are in their proper position. Not only the motion of the disk and the position of the pockets must be related but the time rate of the arm movement must be clearly in mind.

3—In order to do the best work, must have a feeling that the arm is absolutely under control.

4—Must have confidence; yet overconfidence sometimes produces a low score.

5—Must have a strong purpose in mind, in order to do best work."

The increase in the subject's power to concentrate his attention upon the work was very noticeable. After he had practiced several times, the work appeared to take hold of him. There was a set to his whole body and a certain rigidity that was entirely absent at first. This grew into a habit so that when the subject watched one of the other subjects perform he was apparently under this strain. A very high degree of accuracy with great speed was required but since each trial lasted but slightly over five seconds, the fatigue element did not enter.

TABLE XVII

Subject M.
Experiment—Throwing shot.
The first column shows the date of practice. The second column shows the number of shot hit; the third, the number of shot seized; the fourth, the number of shot in the big circle; and the fifth, the number of shot in the pocket. This outline is true of each of the three divisions on the page.

Jan.	20	56	40	27	12	Mch.	8					Apr.	24				
	21	79	58	46	16		9	78	60	50	27		25	80	78	77	74
	22	80	61	51	21		10	80	67	56	41		26				
	23	80	59	52	26		11	80	72	68	57		27	80	78	73	69
	24	79	55	49	19		12	80	67	63	43		28	80	73	73	67
	25						13	79	66	60	28		29	80	77	77	70
	26	80	70	60	31		14	79	67	59	38		30	80	78	78	69
	27	80	59	53	21		15					May	1	80	73	72	58
	28	74	55	51	17		16	80	72	70	35		2	80	77	75	66
	29	79	60	52	17		17	79	68	60	34		3				
	30	80	60	57	21		18	80	68	66	45		4	80	76	76	70
	31	80	59	52	24		19	80	72	69	52		5	80	74	71	67
Feb.	1						20	77	65	64	41		6	80	77	74	60
	2	80	59	53	32		21	80	71	68	49		7	80	71	71	60
	3	77	51	43	24		22						8	80	73	74	51
	4	79	61	51	36		23	80	66	66	26		9	80	74	74	61
	5	79	61	50	29		24	80	71	69	33		10				
	6	80	65	59	47		25	80	72	66	38		11	80	75	75	67
	7	80	74	68	49		26	80	66	63	44		12	80	78	75	69
	8						27						13	80	79	75	73
	9	79	58	48	18		28	80	74	69	49		14	80	73	73	67
	10	79	66	59	26		29						15	80	74	74	67
	11	80	71	63	47		30	80	66	65	29		16	80	75	73	68
	12	80	68	63	31		31						17				
	13	75	65	59	44	Apr.	1	80	71	67	57		18	80	77	76	74
	14	79	75	68	56		2	80	73	71	50		19	80	77	76	71
	15						3	80	73	71	54		20	80	72	72	67
	16	79	74	70	28		4	80	72	66	56		21	80	80	78	73
	17	80	74	68	45		5						22	80	78	77	74
	18	78	71	67	43		6	80	73	68	53		23	80	77	77	72
	19	79	68	65	42		7	80	75	73	68		24				
	20						8	80	78	78	68		25	80	76	76	70
	21						9	80	74	74	70		26	80	78	77	67
	22						10	80	77	75	63		27	80	78	78	75
	23	80	74	65	54		11	80	78	74	64		28	80	80	78	72
	24	78	65	61	45		12						29	80	73	73	68
	25	80	69	61	42		13	80	76	72	59		30	80	77	76	70
	26	80	72	70	62		14	80	75	75	65		31				
	27	80	70	67	58		15	80	76	75	65	June	1	80	76	75	67
	28	79	69	64	50		16	80	79	73	61		2	80	75	75	68
Mch.	1						17	80	80	79	71		3	80	76	75	65
	2	78	67	60	35		18	80	77	77	72		4	80	78	77	75
	3	80	71	62	54		19						5	80	78	77	73
	4	79	65	53	47		20	80	75	75	67						
	5	79	62	50	36		21	80	78	77	62						
	6	80	63	40	32		22	79	75	75	71						
	7	78	62	48	37		23	80	78	77	68						

Subject Fe. commenced work on Jan. 20 and continued until June 4, 1914. The practice was daily except as noted in Table

XVIII. The conditions under which he worked and the instructions were the same as those for Subject M. The result of his work is shown in Table XVIII and the form of his improvement by Curve XXVII (Plate VI).

This Subject did not analyse his manner of procedure as closely as did Subject M. He at first gave his attention to the seizing of the shot but after a few trials he grasped the situation as a whole. By examining the curves, it is seen that there is considerable difference between his work and that of Subject M. His first part was perfected somewhat more quickly. He failed to make a perfect score only four times after the thirty-second practice. Subject M. had trouble with this part of the work up to the fifty-first practice.

The second and third parts rise rapidly at first and then gradually until about the fiftieth practice. After that they remain almost on a level fluctuating between seventy-six and eighty. The fourth part makes practically no progress until the sixth practice; after that it rises rapidly until the ninth practice. The large fluctuations between the fourteenth and seventeenth practices were due to the belt slipping on the motor. If this trouble had not occurred, it is likely the rise would have followed a more gradual course up to the thirty-sixth or thirty-ninth practice. After that there is a period of practically no progress up to the sixty-first practice, or during twenty-three or four days. At that point, he found that he could give a longer swing to his arm and thus hit the pocket more often. This brought the fourth part to the final level which lasted to the end of the practice. Except this last case, the subject did not discover any factor that had helped him in the improvement.

TABLE XVIII

Subject Fe.
Experiment—Throwing shot.
The first column shows the date of practice. The second column shows the number of shot hit; the third, the number of shot seized; the fourth, the number of shot in the big circle; and the fifth, the number of shot in the pocket. This outline is true of each of the three divisions on the page.

Jan.	20.....	76	58	30	0	Mch.	7.....	80	72	67	59	Apr.	22.....	80	79	77	58
	21.....	80	69	47	1		8.....						23.....	80	77	73	70
	22.....	79	70	41	2		9.....						24.....	80	78	78	74
	23.....	80	67	40	0		10.....	80	75	75	61		25.....	80	80	80	69
	24.....	80	65	58	3		11.....	80	75	73	64		26.....				
	25.....						12.....	80	75	71	56		27.....				
	26.....						13.....	80	77	74	62		28.....	80	80	80	70
	27.....	78	61	62	12		14.....	80	77	74	61		29.....	80	76	76	72
	28.....	80	61	57	16		15.....						30.....	80	77	77	73
	29.....	79	68	60	28		16.....					May	1.....	80	80	78	73
	30.....	79	59	53	31		17.....	80	77	75	64		2.....				
	31.....	78	68	64	26		18.....	80	78	77	65		3.....				
Feb.	1.....						19.....	79	69	69	58		4.....				
	2.....						20.....	80	79	76	68		5.....	80	79	78	57
	3.....	78	64	58	20		21.....	80	79	76	68		6.....	80	77	76	66
	4.....	79	70	62	29		22.....						7.....	80	77	76	67
	5.....	79	73	70	25		23.....						8.....	80	78	78	67
	6.....	75	70	56	33		24.....	80	78	76	62		9.....	80	79	79	72
	7.....	77	75	64	53		25.....	79	78	77	67		10.....				
	8.....						26.....	80	80	79	66		11.....				
	9.....						27.....	79	72	72	65		12.....	80	80	79	74
	10.....	79	73	68	35		28.....	80	79	76	69		13.....	80	77	73	67
	11.....	80	74	64	56		29.....						14.....	80	80	80	74
	12.....	80	74	71	45		30.....						15.....	80	80	80	72
	13.....	80	73	64	45		31.....	80	75	74	61		16.....	80	80	80	65
	14.....	79	70	62	46	Apr.	1.....	80	77	77	68		17.....				
	15.....						2.....						18.....				
	16.....						3.....						19.....	80	78	78	70
	17.....	80	71	66	46		4.....						20.....	80	79	79	69
	18.....	79	71	69	39		5.....						21.....	80	80	80	77
	19.....	80	75	71	43		6.....						22.....	80	77	77	69
	20.....	78	70	68	36		7.....	80	77	76	70		23.....	80	79	79	69
	21.....	80	71	67	36		8.....						24.....				
	22.....						9.....	80	77	76	83		25.....				
	23.....						10.....	80	79	79	67		26.....	80	79	77	70
	24.....	80	73	69	35		11.....	80	77	77	62		27.....	80	80	79	72
	25.....	79	77	74	50		12.....						28.....	80	80	80	75
	26.....	80	72	71	55		13.....						29.....	80	77	76	72
	27.....	80	77	75	50		14.....	80	76	76	61		30.....	80	78	75	64
	28.....	80	77	76	54		15.....	80	79	77	52		31.....				
Mch.	1.....						16.....	79	78	77	52	June	1.....				
	2.....						17.....	80	78	77	60		2.....	80	77	76	73
	3.....	79	77	74	51		18.....	80	79	79	69		3.....	80	79	78	76
	4.....						19.....						4.....	80	76	76	71
	5.....	80	74	73	56		20.....										
	6.....	80	77	72	54		21.....	80	77	75	65						

Subject S. commenced work on Apr. 2, and continued until May 29, 1914. She worked under the same conditions as the other two subjects and was given the same instructions. The

results of her work are given in Table XIX. Curve XXVIII (Plate VII) shows the nature of her improvement. During the first two practices she said that the motion of the disk made her dizzy. After that she experienced no more trouble in this respect. She mastered the manipulation of the tongs more quickly than did the other two subjects. The quickness and accuracy of the hand movement enabled her, after about the seventh practice, to devote all her attention to the throwing of the shot. This made her problem nearly the same as when only one factor was to be observed.

An examination of the curve that represents her progress shows that after the seventh practice the first three parts show little improvement. With a few exceptions, the second and third parts fluctuate between seventy-six and eighty. The fourth shows an almost constant rise with the usual daily fluctuations.

TABLE XIX

Subject S.
Experiment—Throwing shot.
The first column shows the date of practice. The second column shows the number of shot hit; the third, the number of shot seized; the fourth, the number of shot in the big circle; and the fifth, the number of shot in the pocket. This outline is true of each of the three divisions on the page.

Apr.	2.....	71	55	54	12	Apr. 23.....	80	77	77	35	May 13.....	80	78	78	51
	3.....	73	65	59	12	24.....	80	75	75	45	14.....	80	75	74	62
	4.....	79	69	64	23	25.....	80	78	78	47	15.....	80	79	79	59
	5.....					26.....					16.....	80	77	76	42
	6.....	73	69	57	17	27.....	80	75	74	46	17.....				
	7.....	79	73	61	22	28.....	80	79	77	60	18.....	80	77	77	52
	8.....	78	72	68	25	29.....	80	79	79	65	19.....	80	79	78	59
	9.....	80	75	72	23	30.....	80	79	76	55	20.....	80	77	76	67
	10.....	80	76	76	35	May 1.....	80	77	64	48	21.....	80	78	78	59
	11.....	80	80	77	28	2.....	80	77	77	42	22.....	80	76	76	54
	12.....					3.....					23.....	80	79	79	63
	13.....	80	75	71	44	4.....	80	76	73	44	24.....				
	14.....	80	75	75	39	5.....	80	80	78	51	25.....	80	79	79	63
	15.....	80	73	72	37	6.....	80	77	75	57	26.....	80	78	78	60
	16.....	80	80	78	37	7.....	79	77	77	56	27.....	80	79	79	63
	17.....	80	80	77	34	8.....	80	77	77	48	28.....	80	77	77	69
	18.....	80	74	73	32	9.....	80	78	78	61	29.....	80	78	78	72
	19.....					10.....					30.....	80	78	77	67
	20.....	79	71	70	27	11.....	80	78	76	60	31.....				
	21.....	80	78	77	40	12.....					June 1.....	80	78	78	72
	22.....	80	77	77	37	13.....									

Subject Cd. was selected primarily because she had had a large amount of practice on the piano. She commenced work on April 2, and continued until May 29, 1914. The conditions under which she worked and the instructions given were the same as those for the other subjects. The result of her practice is shown in Table XX and the form of improvement is shown in Curve XXIX (Plate VIII). She did the work with a sort of passive indifference. There was no sign of the effort which was so characteristic of the other subjects. She was able to improve very rapidly. In six days the first three parts had reached a level that was not improved afterwards. In twelve practices the fourth part had reached a level that on an average was not surpassed during the rest of the practice. From the twelfth to the forty-third practice there was little improvement. This seems to indicate that the work was partly done when she started. The point that was hardest for the other subjects, that of the position of the pocket, caused her no particular trouble. After just a few practices she would move her nand exactly to the same point and in the same way.

TABLE XX

Subject Cd.
Experiment—Throwing shot.
The first column shows the date of practice. The second column shows the number of shot hit; the third, the number of shot seized; the fourth, the number of shot in the big circle; and the fifth, the number of shot in the pocket. This outline is true of each of the three divisions on the page.

Apr.	2.....	64	61	30	00	Apr. 22.....	79	73	71	44	May 11.....				
	3.....	72	64	60	15	23.....	80	74	73	55	12.....	79	79	76	59
	4.....	78	70	69	21	24.....	79	70	67	45	13.....	80	73	73	52
	5.....					25.....	80	76	72	65	14.....	80	74	75	61
	6.....	74	72	68	13	26.....					15.....	80	77	77	67
	7.....	77	72	71	30	27.....	80	72	70	55	16.....	80	74	74	62
	8.....	80	75	72	21	28.....	80	74	73	61	17.....				
	9.....	79	71	70	26	29.....	79	73	71	54	18.....				
	10.....	80	78	76	38	30.....	79	68	67	42	19.....	80	74	73	54
	11.....	80	79	79	35	May 1.....	80	76	75	58	20.....	80	75	74	46
	12.....					2.....	76	68	67	53	21.....	79	71	71	54
	13.....	79	71	71	30	3.....					22.....				
	14.....	78	75	74	44	4.....	80	70	69	55	23.....	80	76	76	61
	15.....	80	78	74	57	5.....	79	73	69	51	24.....	80	73	72	64
	16.....	79	71	69	48	6.....	80	76	75	45	25.....				
	17.....	80	79	76	62	7.....	78	69	69	47	26.....				
	18.....	80	76	72	63	8.....	80	73	73	53	27.....				
	19.....					9.....	80	72	71	55	28.....	79	71	71	56
	20.....					10.....					29.....	80	77	74	64
	21.....														

By comparing these four curves, it may be seen to what extent each of the four factors influenced the work and what the effect is on the form of the curves. It will be seen that in all the curves except XXVIII the problem of hitting the shot was not mastered until several weeks practice. This period was extended longest in the case of Curve XXVI. In Curve XXIX, this element caused trouble until the end of the practice.

The second and third parts of Curve XXVI show three rises and three plateau periods. The first rise from the first to the third practice represents the period when the subject was getting acquainted with the rate of rotation of the disk. From the third to the fifteenth practice, his attention was on the general direction of the pocket and on the tongs. At the sixteenth practice there was a marked improvement in his ability to handle the tongs. From the sixteenth to the fiftieth practice the attention was centered on seizing and throwing the shot while the hitting of the pocket was ignored. At the fifty-first practice, the subject commenced to watch one full rotation of the disk before starting to strike and he continued to attend to this phase of the work until the fifty-seventh practice. Here he improves his seizing on the basis of better striking and also notices a better way of standing.

Curve XXVII shows no such steps in the second and third parts. There is a general rise up to about the fiftieth practice and after that little improvement. The subject's manner of attending gave him no factor for separate consideration. The second and third parts of Curve XXVIII show about the same form as the same parts of Curve XXVII. The first factor having been mastered after about six practices there was no element to cause trouble and no particular improvement in the plan of the work. In Curve XXIX the second and third parts rose rapidly for four or five practices, but did not succeed in reaching so high a level for this part of the work as that reached by the other subjects.

Curve XXVI shows in the fourth part a very pronounced plateau type of curve. At first, there is a slight rise partly due to the subject's getting acquainted with the apparatus and partly

the result of his improving the method then being used. After about sixteen practices, a level was reached in this part of the curve that remains practically constant until the fifty-eighth practice. What was going on at this time may be partly accounted for by noticing the other parts. The rise to the next level involved two factors at least. One was this mastering the first element and the second followed as a consequence from this. The subject being somewhat free discovered the proper way to get the most suitable standing position. He had noted a feeling of ease when in the proper position even before he had analysed a method to make sure of it every trial.

The fourth part of Curve XXVII shows no improvement for four practices. During this time, the subject had given all his attention to the other factors. Then by attending the whole problem he reached a level at about the forty-first practice which seemed to have been the limit for the method he was using. After he had discovered a new method, that of extending his arm farther, he brought this part of the curve to the next level. The fourth part of Curve XXVIII shows a constant rise for the reason that the subject was attending to this part from the first. No especial changes in method were noted. The fourth part of Curve XXIX shows a rapid rise for a few practices which seems to have been the result of adapting an ability already existing to this new situation. After this process had become perfect no further advance was made. No new method was devised and no special effort was put forth. There was a drop from the twenty-first to the thirty-second practice which appeared to be the result of indifference.

GENERAL DISCUSSION

The first aim of this study was to get further information in regard to the long period fluctuations or plateaus in the curve of learning. It is seen from these experiments that only in the last division of the work are there plateaus of long length. Neither in the ball tossing experiments nor in the work done by Swift, although the work extended over a considerable period of time in some cases, does there appear a long arrest between two rapid

progress periods. The middle division of this work where only one element was involved did not in any case extend over a period of time of sufficient length to show a long plateau. In the last division of the work, however, in one case in particular the plateaus were very pronounced if the part representing the shot thrown in the pocket is considered.

No one, so far as the writer is aware, has contended that the long period plateaus are a necessary part of all learning curves regardless of the type of learning. Bryan and Harter, however, in their work were convinced that these long periods of slow progress were necessary in the curves for receiving the telegraphic language. Book found the long period fluctuation in two of the curves he obtained for learning typewriting but he did not think they were a necessary part of the development. The last division of this work shows that there may be or may not be plateaus of long length in the same type of work.

One way of deciding the question of the necessity of plateaus for a particular type of learning would be to try a large number of individuals and see if they uniformly had plateaus in their improvement. Another way and a more satisfactory plan would be to attempt to analyse out the factors and see just what is involved in the formation of the arrest period. It has been seen (see Introduction to this study) that Bryan and Harter attributed the plateaus to the time it takes to form different-order habits: Swift, although he found only short plateaus, believes for the most part that they can be explained on the basis of the associations being made automatic; and Book thought they were the result of lapse of attention or misdirected attention. In none of these publications was an attempt made to so arrange the work that an opportunity would be given to see just how the separate factors acted during a plateau period and what effect the diferent reactions to them by different subjects had upon the work as a whole.

The last division of the work reported in this study was planned with the intention of having a number of elements involved in such a way that the subject could attend to all of them at once or attend to one or more of them separately from the

rest. It may be objected that the factors that were measured in this work must follow one another in a certain order and that the subject could not modify this or in other words change the order of the factors. This is true,—the subject could not throw or hit the pocket until he had struck or seized the shot—but this did not prevent him from giving practically all his attention to the first factor or distributing it over the work as a whole. What occurred in the subjects tested for this work may be seen by examining the different divisions of the curves obtained for the four subjects used in this experiment.

If the last or fourth part (the part obtained by using the shot that hit the pocket as a unit of measure) of the curves for each of these subjects be observed, it will be seen that one of the subjects (Subject M.) had two rises and two marked plateaus. Subject Fe. showed a short arrest period at first, a rapid rise and then another period of arrest. Subject S. showed no sign of an arrest period in this part of her work but an almost constant rise from one end of the curve to the other. Subject Cd. at first showed a rapid rise and then a long period of delay which was not broken at the end of the practice.

If the hitting of the pocket had been the only goal and the unit of measure had considered nothing else, the explanation of the curve would have had to depend upon introspections. Here, however, the other parts of the curve give an objective basis for explanation. Subject M. who had two pronounced plateaus attacked the work in parts; he attended to the first or basal factor until it was under a high degree of control. After that he took up the other factors. It is true the improvement was due, in part, to improvement in method but this depended upon the fact that his attention was free to attack the other part of the problem. In this case the subject followed a plan parallel to what Bryan and Harter explained when they spoke of the lower order habits being completed or automatized first. There was no evidence in this subject of a lapse and renewal of attention as Book pointed out in his work on typewriting. It may be that the work was such that the subject could see that he was making progress all the time; that is, he could see that he was hitting the shot or

seizing them better and this kept up his interest. However, the fact stands that it was not lapse of attention that caused the long arrest in the fourth part of the curve.

Subject Fe. had a short period of arrest in the fourth part of his curve, while there was a relatively large improvement in the other parts. This indicated that he was attending to those first factors. Later all the parts of the curve make gains together. He was able to attend during this time to the process as a whole. When he reached a level near the limit of his ability to improve, all the divisions of the curve sloped off more nearly parallel to the x-axis.

Subject S. had no plateau in the fourth division of her work, because, as can be seen from the other three parts of her curve the first three factors presented her no trouble. As has been explained, the quickness of her hand movement and the accuracy with which she used the tongs enabled her to master these factors in a short time. In her work, it was simply a case of giving her attention to a single factor and the curve of the type of the simple association curve (see discussion on the form of the curves) was the result.

Subject Cd. had much the same form of curve in the fourth part but the rise was more rapid. The reason for that has been explained already. The practice on the piano was a training that only needed special adaptation. This took place rapidly. After that she improved the work in a short time to a point near the limit of her ability.

From this study and from the other experiments done in this field, the writer feels justified in drawing the following conclusions in regard to the plateau. There is no evidence to show that they ever occur in learning processes where there is only a single association involved. They may or may not occur in a complex learning process. If the factors involved are of such a nature that they must be improved together or if the subject is able to attend them as a whole, there will be no plateau. If, however, the nature of the work is such that the factors must be attended in succession or the subject gives his attention to the separate factors, as such, there will be plateaus.

Ball-tossing may be taken as an illustration of where the factors involved must be improved together. At least three of these factors have been mentioned and studied to some extent in this work. If these factors are taken, it is seen that it is practically impossible for the subject to separate them. One of them counts for nothing unless the others go along with it. It might be conceived that the subject could practice throwing the ball a certain height or in a certain direction, yet in this case, he would either have to watch it or use some other means to get a selective factor, that is, to show when an improvement is made and this would give him a criterion for the time element. Again if he improves his ability to throw in a certain direction and does not improve his ability to shift his hand to the position where the ball will fall, there will be no improvement in the unit of measure.

In the work on throwing the shot, the separate factors could be improved in succession. The subject could practice with his attention fixed on the seizing of the shot until he had acquired the ability to hit and seize practically every one in order, or he could distribute his attention on the separate factors about equally. The aim was to have the subjects learn each factor in order but some of the subjects were more completely able to do this than others. In such cases as this last division of work where the shot throwing is the problem, the attention will be given to a part or the whole of the work according to all the conditions that govern the attention of the individual at the particular time of the practice.

The Daily Fluctuations

The daily fluctuations appeared in all the work that was done. In fact there seem to be no cases of learning where they do not appear. They indicate very clearly the variation in the physical and mental condition of the subject from day to day. At times the subjects were able to tell in advance that they would make a good score but in this work, just as Swift found, their thinking that they would make a good score was no proof that they would. It was noted that Subject F. in his tossing the pieces of hard rubber was set back by his confidence that he would make a high score after the first relatively high score.

Whether these fluctuations were greater at the beginning or at the end of the practice depended upon the nature of the work and the unit of measure. If there was a definite set limit for the unit of measure as in the case of the direction, force, and time curves, or in the shot throwing curves, the later variations were likely to be less. But on the contrary if the unit of measure had no limit other than fatigue or some physical or mental factor as in the case of the ball-tossing, the later fluctuations were relatively large.

This work differs from a large part of the experimental work that has been done in this field in that the material from day to day was kept exactly the same. In work like typewriting, shorthand, and telegraphy where different material is used on succeeding days, the fluctuation may be partly at least accounted for by the fact that the subject matter was more difficult on some days than on others.

The fluctuations are useful for indicating the relative amount of ability shown daily by subjects doing the same kind of work but it must be remembered that the nature of the unit of measure will largely determine the apparent amount of fluctuation each day. It may also be noted that because the fluctuations are larger toward the end of the curve, one should not conclude that the daily ability varies more at that time of the practice.

The time and direction curves may be taken to illustrate the first point. Because the average deviation of the time curves was less than that of the direction curves, it does not follow that the subjects varied less daily from a certain line of improvement in judging time than they did in judging direction. If more pockets had been made on the disk, the variation for the time test would have been greater though the actual daily ability would have been the same.

Again if the ball tossing curves, where the number of catches form the unit of measure, are noticed, it will be seen that the latter part of the curves shows wide daily fluctuations. If it were true that catching ten balls meant the same whether they are the first ten or the ten between ninety and a hundred then these fluctuations near the end of the curve would mean a greater

daily variation in ability, but no one is likely to contend that this is true.

That the fluctuations may be seen to be due to the nature of the unit of measure, attention need only be called to the forms of Curves IIa and IVa. The latter part of these curves shows little variation and gives a directly opposite result from what the first method of plotting the ball tossing curves seems to indicate.

The General Form of the Curves

For the purposes of discussion, the curves of learning may conveniently be divided into four classes. When the number of catches in a given number of trials (Curves I to V), the reciprocals of the number of errors per given group (Curves IX and X) as five hundred or one thousand, or the average number of catches in thousand groups (Curves XI to XV) are used as the basis for the unit of measure the curves all show the same general form. They are all concave to the y-axis. Some of them do not show this peculiarity to so great an extent as others but this can be explained on the ground that the subject had had previous practice or similar practice which modified the form of the early part of the curve.

Another class is where the slope is relatively constant up or down, accordingly as the unit of measure is such that it increases or decreases, until a point is reached near the limit of the subject's skill. This class is illustrated by the experiments on direction, force and time.

A third class is where the curve rises or falls rapidly at first and then gradually approaches parallelism with the x-axis. This class is illustrated by the second and third divisions of some of the shot throwing curves and those for telegraphic sending in the study of Bryan and Harter; also by the ball-tossing experiments when the unit of measure is the number of errors made in catching a definite number, as five hundred or a thousand, or the percent the number of catches is of the number of tosses.

The fourth class is the long level plateau class where there is a relatively rapid rise and then a period of delay and then another period of rapid rise. This is illustrated by the fourth part

of the curve of Subject M. obtained for shot tossing, and also by some of the typewriting curves of Book and the telegraphic receiving curves by Bryan and Harter.

The curves for ball tossing when the unit of measure is the number of catches made in a certain number of trials, show a long period when comparatively little progress is made and then a sudden rise at the end. This is true regardless of whether the subject attempts to use a particular method, or to develop some special part of the work. It is true also regardless of the distribution of practice. When the subject had a practice period of approximately five hundred catches instead of ten trials, the curve obtained when ten trials was made the basis of the score, was the same in form (Curve VIII).

There are a number of factors that must be considered in trying to interpret the significance of this type of curve. The long period of apparent slow progress at the beginning of the ball tossing curves where a number of trials is made the unit for the divisions on the x-axis and the sum of the catches is the basis for the divisions on the y-axis may be explained by the fact that the long period represents relatively little practice. When the subject is able to make less than one hundred catches during the ten trials he gets much less practice than when he can make a thousand or more catches in the same number of trials. This holds true for Curve VIII, when the practice period was five hundred but the divisions on the x-axis were based on groups of ten trials as well as for the first five ball tossing curves.

The rapid rise at the end of all the curves of this type is due to the peculiar nature of the unit of measure; that is, in the ball tossing curves where the number of trials is used as the basis for divisions on the x-axis (Curves I to V and also VIII); the curves where the reciprocals of the number of errors per given group as five hundred or one thousand (Curves IX and X) are used; and the curves where the averages per thousand (Curves XI to XV) are made the basis for the divisions on the y-axis.

In the case of Curves I to V and VIII, ten trial groups are made the basis for divisions on the x-axis but a trial here means the number of catches between two errors or misses. It follows

that the significance of a trial in the earlier and later part of the work in any experiment varies greatly. The implication is that ten catches represent the same amount of skill whether they are made on the first day's practice or on the last day's practice or whether it is the first ten caught or the ten between ninety and one hundred, and that to catch one hundred balls in one trial represents a degree of skill ten times as great as to catch ten balls in one trial.

In all the other experiments of this work, the unit of measure would be comparable to a single toss, that is the toss would constitute a trial. The degree of skill would be represented by the proportion of tosses that are successful. If the subject catches ten balls the first time before he misses, he has ten successes out of eleven trials or ninety-one percent would represent his degree of skill. When he catches one hundred balls without missing, he has ninety-nine percent for his degree of success. Instead of his success or skill being ten times as great in the second case as in the first as it would be by the first method, it is really only eight per cent greater.

In the curves where the reciprocals of the number of errors is made the basis for the divisions on the y-axis the result is the same as where the ten trial basis is used. The assumption is that to catch one hundred balls in one trial represents a degree of skill ten times as great as to catch ten balls in one trial. The effect can be seen readily by noting that the vertical distances (distances above the x-axis) vary as a constant divided by a decreasing variable.

When the data used in plotting these first curves, that is the first five for ball tossing are used so as to make the actual amount of practice the basis upon which to count gain in skill a very different form of curve is obtained (see curve IIa and IVa).

In these cases the basis was one thousand catches which was a definite amount of practice and the success was measured by counting what percent this was of the total number of tosses necessary to make the thousand catches. The implication is that a miss is no practice, at least it gives no increase in skill. This method gives practically the same form of curves as taking the

number of catches made in each one thousand tosses as the basis for divisions on the y-axis. Instead of measuring the absolute gain this method measures the relative gain. With this method of measuring gain, there is no rapid rise at the end of the curves.

Thorndike using Swift's data points out that when the average number of tosses is used as the basis for the divisions on the y-axis and the thousand groups are the basis for the divisions on the x-axis, a curve of the form of type three is the result.[27] The data obtained in this work do not give that form of curve when treated in that way.

The second class of curves is where the slope remains up or down depending on whether the unit of measure is such that the values representing the divisions on the y-axis increase or decrease with the increase of skill until a point of development is reached near the limit of its possibilities. This may be determined by the particular function having been perfected as in the case of direction if the subject could have hit the mark every time or by his approaching a place where he could no longer get a selective factor, that is he passes into a realm beyond the threshold of sensory discrimination in that particular field. For instance, if the experiment on force is taken as an example it may be conceived that the subject will be able to hit within a certain minimum distance of the mark every throw but after he reaches a plane where the difference required to put the ball within that space and beyond it falls below a certain fraction of the weight of the ball that he is throwing, he would be able no longer to control the ball so as to reduce the score. At this point the curve would slope off so as to become practically parallel with the x-axis. Sometimes in the case of a single factor acting, the apparatus may at first cause some confusion so that the first few scores may be abnormally high. This makes it appear that the curve rises or falls rapidly at first. The curves obtained for the judgment of time are examples of this.

All the simple association experiments in this work as well as those in other experiments that have been examined show a constant and gradual improvement with the daily fluctuations bal-

[27] Thorndike, E. L. "Educational Psychology," Vol. II, p. 122.

ancing each other, as a rule, in such a way as to approach a straight line until near the limit of the development.

The third type may be the result of a number of elements gradually becoming perfected together and as the elements approach their limit the improvement grows less. Where the work is complex, and the unit of measure is such that it shows the full value of the improvement as fast as it is made, and the subject attends the process as a whole, the curve rises or falls rapidly at first and as the chance for improvement in the separate elements becomes less the rise becomes less rapid. The curves for the sending of the telegraphic language illustrate this form as do also some of the curves obtained by Book in the typewriting experiments, and Curves IIa. and IVa. for ball tossing.

The fourth class of curves is that of the long plateau form which has already been discussed under the head of long time fluctuations. In addition to what has already been said, it is interesting to note that Starch's work on tracing a six-pointed star (*op. cit.*, p. 12) shows the effect of two elements working. He plotted a curve for speed and one for error. The error curve was of the third type and the time curve was in a measure like the fourth type. He does not so state but it is probable that the subject was giving his attention largely to the error side of the work while the plateau period lasted in the time or speed curve.

The writer believes there is no typical curve for all types of learning. Where the work is so simple that the attention cannot be distributed as in the case of rolling a steel ball at a mark or the work is of such a nature that the attention must be given in a certain way, the curves are likely to be of similar form for different subjects. Where the work is complex and the attention can be distributed on different parts of the process, then the curve for different individuals will vary, though the work is the same.

The Influence of Objective and Subjective Factors

This subject has been discussed in detail by Swift and Book. Nothing more was noted in this work than that which emphasizes what they have already said. The objective factors such as

light, temperature, nature of the work, and apparatus, were all very important and any change showed its effect especially in the early part of the practice. The same was true with the subjective factors. However these were not always so easily analysed out. All of these factors showed themselves more influential in the early part of the work when the attention was actively involved than later when the process was more automatic. The experience of expert telegraphers, pianists, and others where there is a large element of motor control involved, demonstrate this beyond doubt. This does not assert, however, that where speed is involved distraction of attention does not affect it.

The Warming up Process

A part of this work showed a warming up and a part did not. The work in ball-tossing shows clearly that after the first trial there were better results. Book also found this warming up tendency to a very marked degree in his work. In the experiments on the judgment of direction there was little evidence of warming up. As the work was such that fatigue would not enter to any great extent, a division of the practice periods into two equal parts ought to show better results for the last half if there was any noticeable warming up. These figures do not show enough advantage to the last half of the work to be of any weight. Wells found in another experiment where a single association had to be formed that there was evidence of warming up to a considerable extent.

In a complex work, the warming up may take the form of renewed associations but in a simple work this is not necessary. It would seem that the difference between the work that Wells had his subject do, that of tapping at maximum speed on a telegraph key, and the work in learning direction consisted in this, that in the first case special preparation was necessary while in the other the ordinary movements of the day would be all that is necessary to keep the arm in proper condition.

The Effect of Short and Long Rest Periods

An examination of the ball-tossing experiments shows that there is no regularity in what happens after a short rest period

of a day or two. Sometimes the score is higher and sometimes lower. This was also true to a large extent in the shot throwing experiments. In the other experiments no opportunity was given to test the effect of short rest periods as the work was continuous from the beginning to the end.

The shot throwing experiments gave an opportunity to test the effect of a short rest period as the work was discontinued on Sunday each week. In the case of Subject Fe. both Sunday and Monday were missed each week. The work of Subjects M. and Fe. extended over nineteen Sundays. Subject M. threw more shot in the pocket on Saturday than on Monday eleven times out of the nineteen. Subject Fe., who had missed two days' practice threw more shot in the pocket on Saturday than on Tuesday nine times out of nineteen. Subject S. threw more shot in the pocket on Saturday than on Monday three times out of eight and Subject Cd., six times out of eight. So far as this part of the comparison goes it is seen that two of the subjects did better after the rest period and two did better before it.

If, instead of counting only the number of shot put in the pocket, the whole work is considered, that is groups of figures in the four columns of the tables for the work immediately before and after the rest periods, it is seen that for Subject M. thirty-one scores were better on Saturday than on Monday, twenty-four were better on Monday than on Saturday and the others are equal. Subject Fe. has twenty-eight better on Saturday and twenty-two better on Tuesday. Subject S. has twelve better on Saturday and eleven better on Monday. Subject Cd. has twenty-one better on Saturday and eight better on Monday. The advantage seems to be slightly in favor of the practice preceding the rest period.

For the long rest period, the results show that where there was not a positive gain, a condition existed that made a rapid gain possible when practice was resumed anew. After a rest of more than six months, subject D. was able to make nearly as high a score the second practice period as he had made the last day in the regular period. Almost a year after this, he was able to make a score nearly twice as high as any he had ever made

before. This was in the first test made. Here was a positive gain with less than a half hour's practice having been taken during the intervening period.

Subject B., after more than a year's rest, made a score on the first day that the practice was resumed with his right hand almost as high as he had ever made before. Two days later he was able to make a higher score than he had ever made before. The left hand had apparently not retained the same amount of skill as the right hand. However, the second retention test showed a marked improvement over the first. The score was as high as any he had ever made in the regular practice except the last three or four where the usual final spurt had occurred.

Subject W., after a rest period of nearly five months, made a score during his second practice higher than he had ever made during his regular practice. A little more than a year after this retention test, he made a score higher than any he had ever made in the regular practice and almost equal to the last score that he made in his first retention test.

Subject F. was the only subject that did not show results in the retention test practically equal to or superior to the best scores in the regular practice. The reasons for this have been explained in the discussion of his work.

Although the work was not carried very far, one interesting point to note is the rapidity with which the improvement takes place in the repeated retention tests. Subject D. in his second retention test which was taken two days after his first shows an improvement of nearly twenty-five per cent over the first one. Subject B., made a gain of almost thirty per cent in the second test over the first with his right hand. With his left hand there was a gain of forty-three per cent in the second test over the first. Subject W., in his second test, showed a gain of nearly ninety per cent over the first. Subject F. was the only subject that did not show a gain in the second retention test over the first. In his case there was a loss of about twenty per cent.

It is interesting to note that this rapid regaining of an acquired ability is closely parallel to the rapid improvement in an instinctive response that has been delayed for a short time. Shepard and

Breed found in their study of chicks[28] that if the pecking response of the chicks is delayed for a few days the accuracy of the pecking increased much more rapidly than it did when the instinct took its normal course; in other words the chicks that had been delayed soon gained an ability equal to those that had normally developed.

The only place in this study that a test was made for the effect of a long rest period, except the ball tossing experiments, was for direction with Subject W. His first test showed that he had apparently lost much of his former skill. The reason for that has been already given in the discussion of that experiment. His second test taken immediately afterwards showed that he had regained practically all the skill he had acquired by his previous training.

The data obtained in these tests only confirmed what has been pointed out by Swift, Book, Wells, and others.

Summary

1.—The plateaus of learning depend upon the factors involved in the process to be learned and upon the distribution of attention. They are not found in simple types of learning and may or may not be found in complex types.

2.—The daily fluctuations are common to all types of learning and depend upon the objective and subjective factors involved. They may be deceptive because of the influence of the nature of the unit of measure upon them but they are useful for the purpose of comparing the daily variability of two or more subjects that are at the same point of development in doing the same type of work.

3.—Both the factors involved and the attention of the subject influence the general form of the curves of learning. Where the work is simple, that is requires a simple sensori-motor association, there will be a typical curve common to different subjects. This is also true where the work is more complex and the factors must, from the nature of the work, be attended in a certain order.

[28] Shepard, John F. and Breed, F. S., "Maturation and Use in the Development of an Instinct." Jour. of Animal Behavior. July-August, 1913, vol. 3, no. 4, pp. 274-285.

4.—Objective and subjective factors have a very great influence on the learning, especially in the early part of the work.

5.—The warming up process is the necessary accompaniment of all work where the ordinary daily activity does not provide the special preparation required for performing the work effectively.

6.—The results do not show that a short rest period has any marked effect on the work one way or the other.

7.—After a long rest period the subject is found to be in a condition to improve very rapidly. In some cases the results show that they have actually gained power during the rest period.

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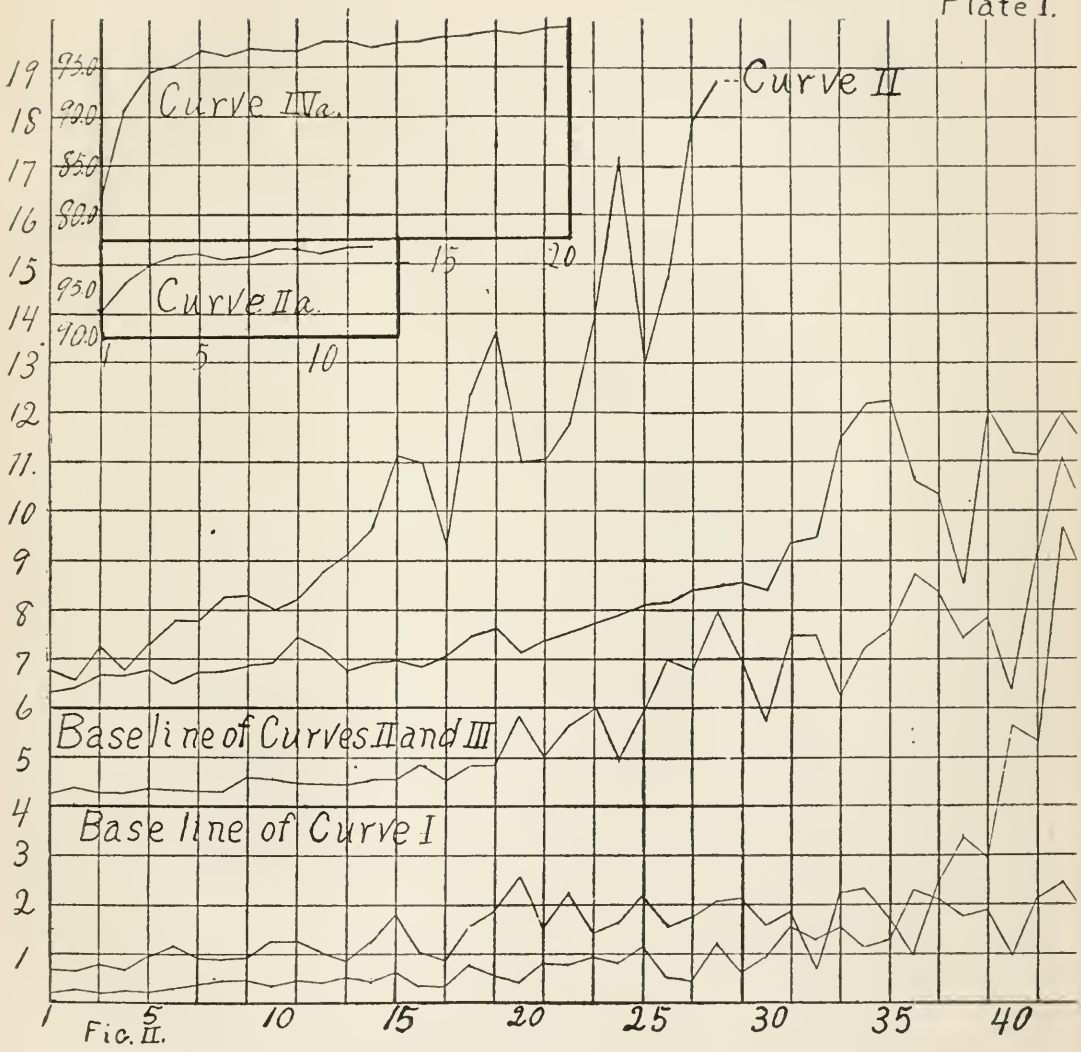
CURVES AND PLATES

Plate I.



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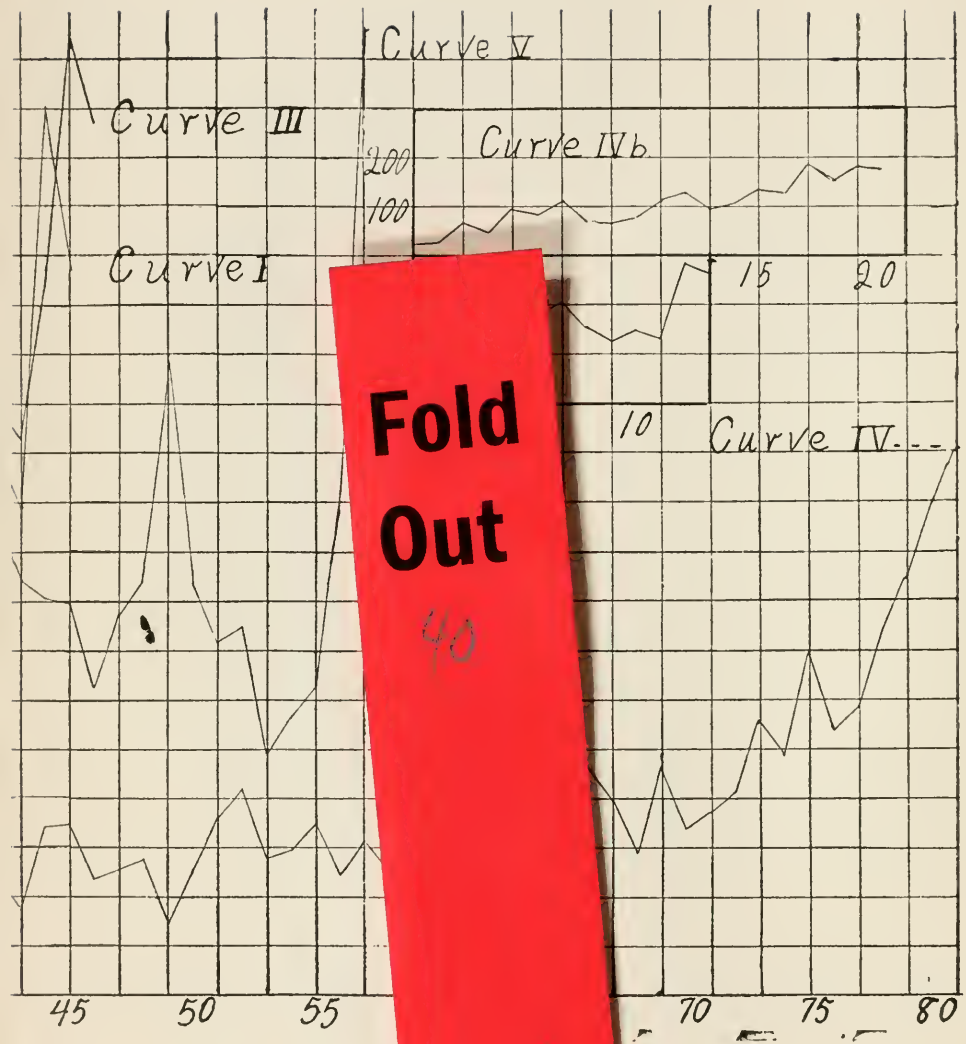
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Curve III
Curve IVb
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Curve I
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Curve IV.
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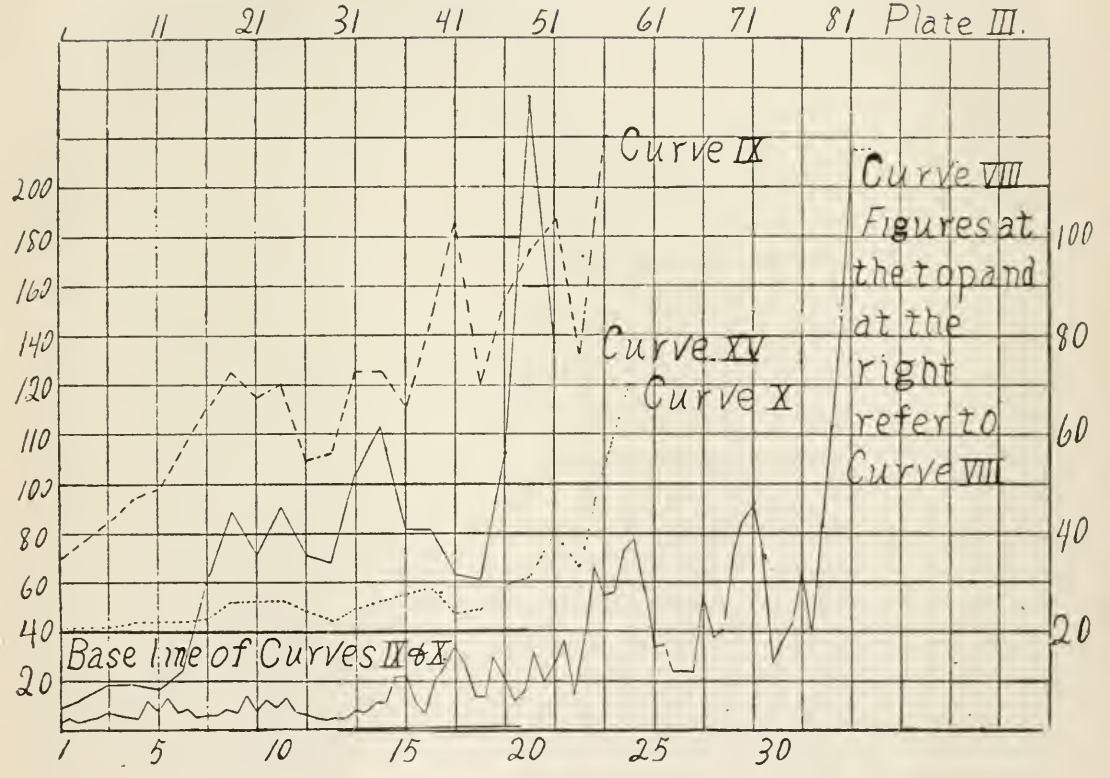
Plate III.
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Curve IX
Curve VIII
Figures at the top and at the right refer to Curve VIII
Curve XV
Curve X
Base line of Curves IX & X
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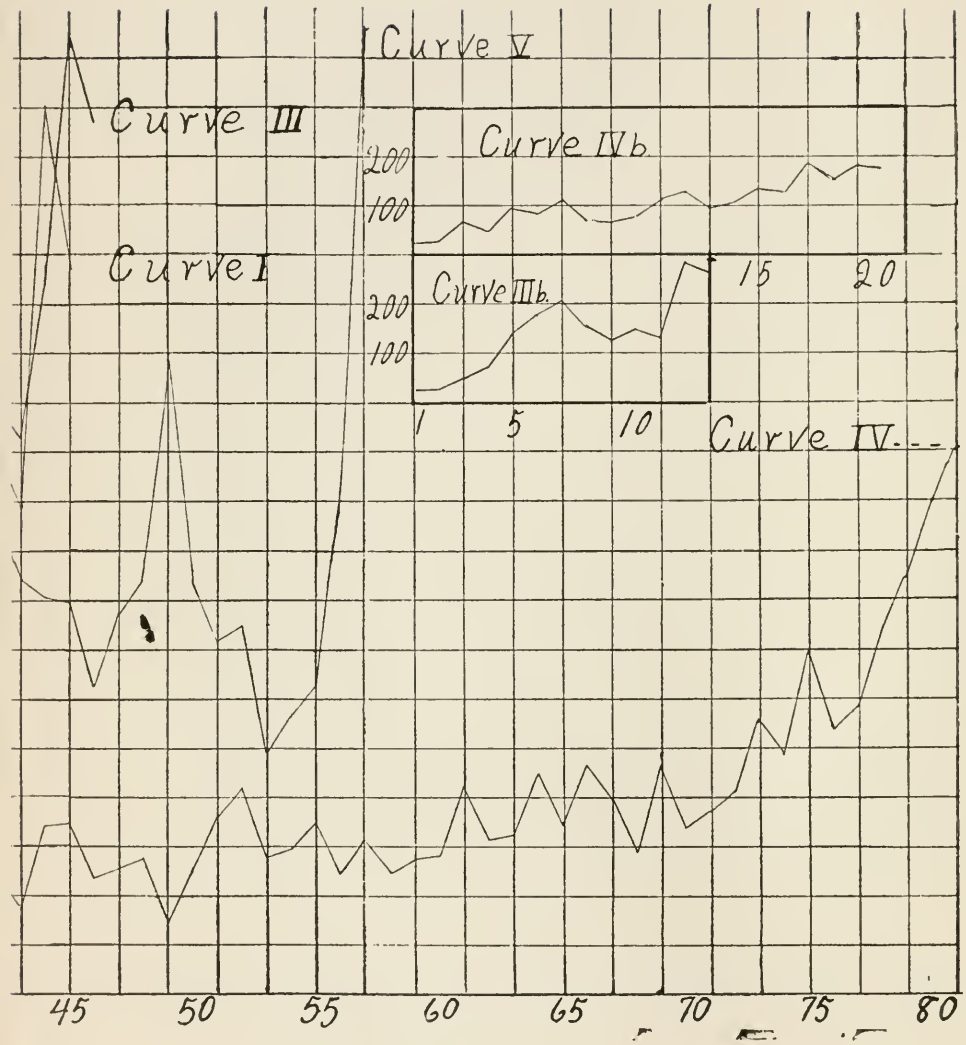
Curve V
Curve III
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Curve IV.
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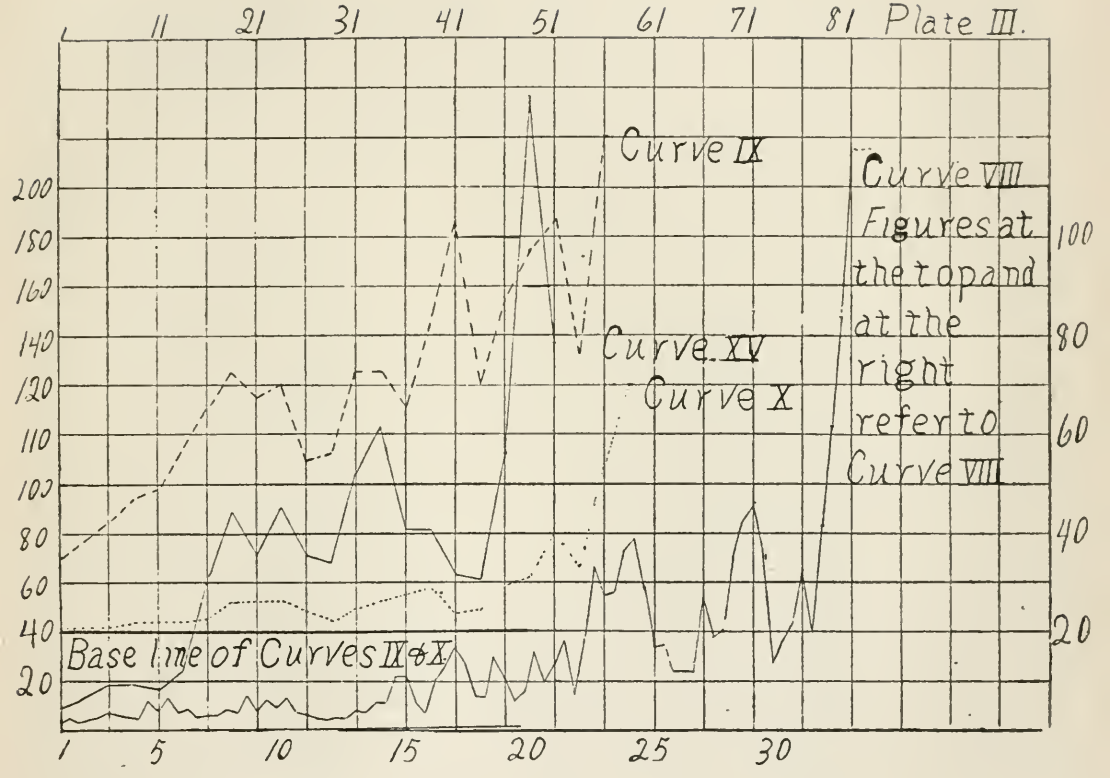
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Curve VIII
Figures at the top and at the right refer to Curve VIII
Curve XV
Curve X
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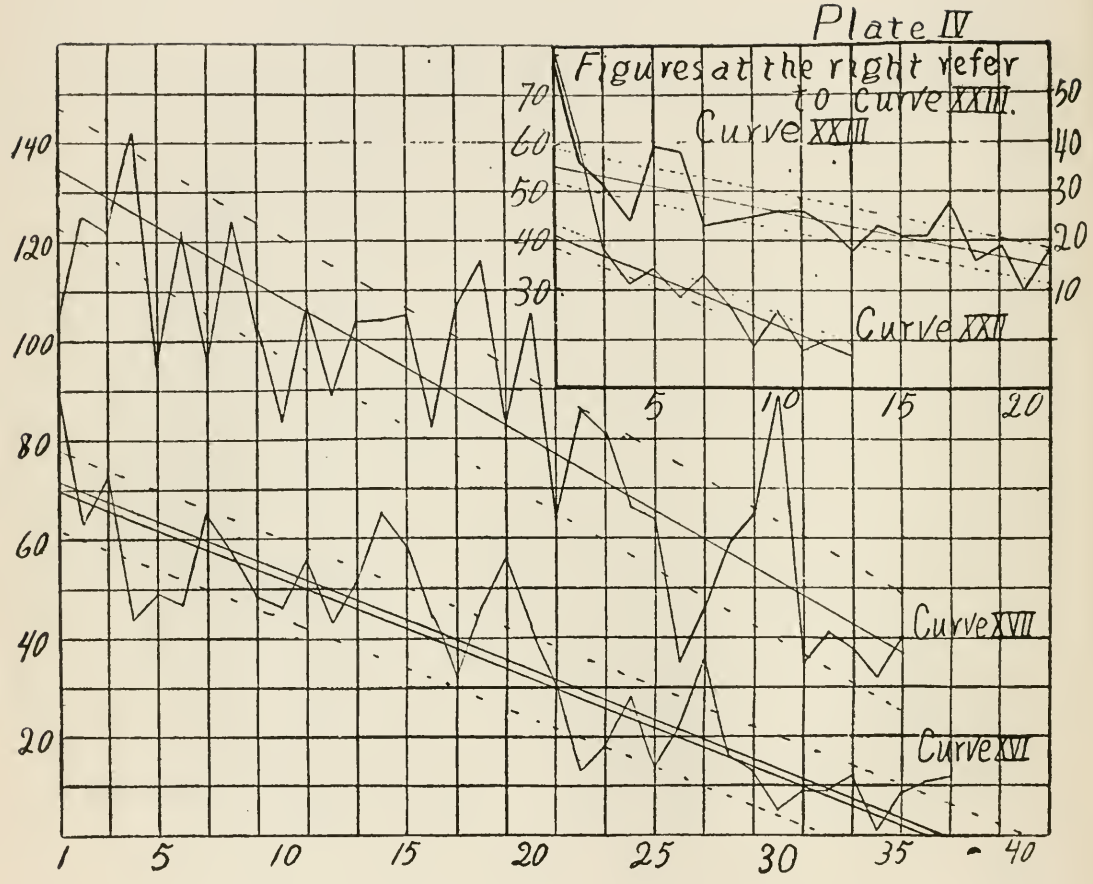
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Curve XXIII
Curve XXII
Curve XVII
Curve XVI
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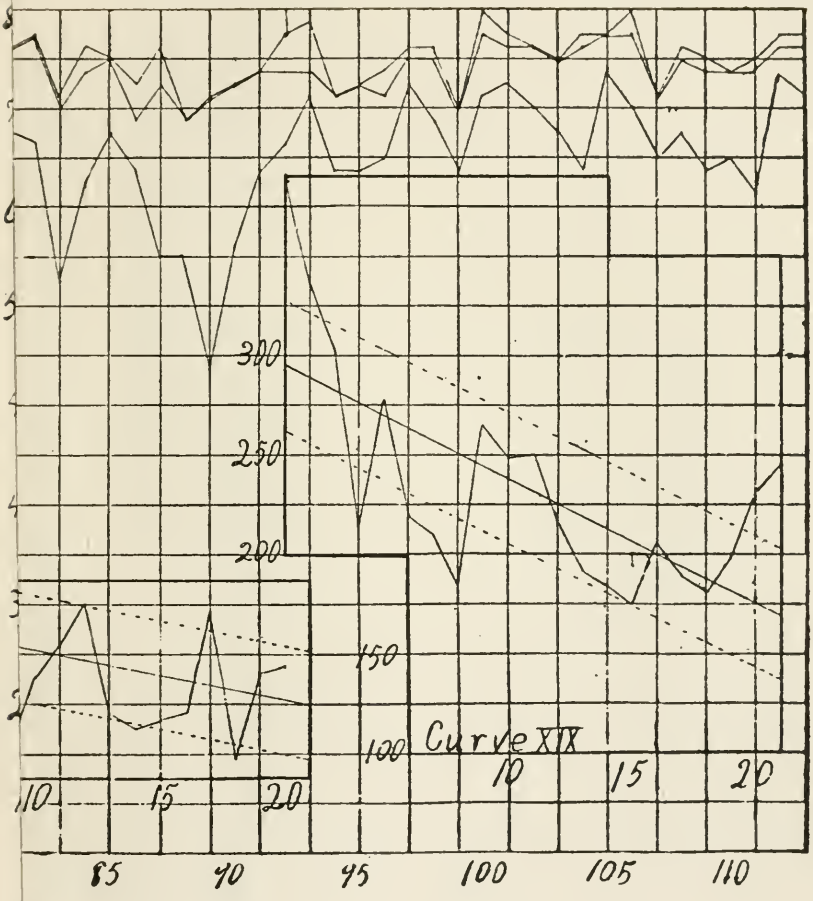
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Curve XIX
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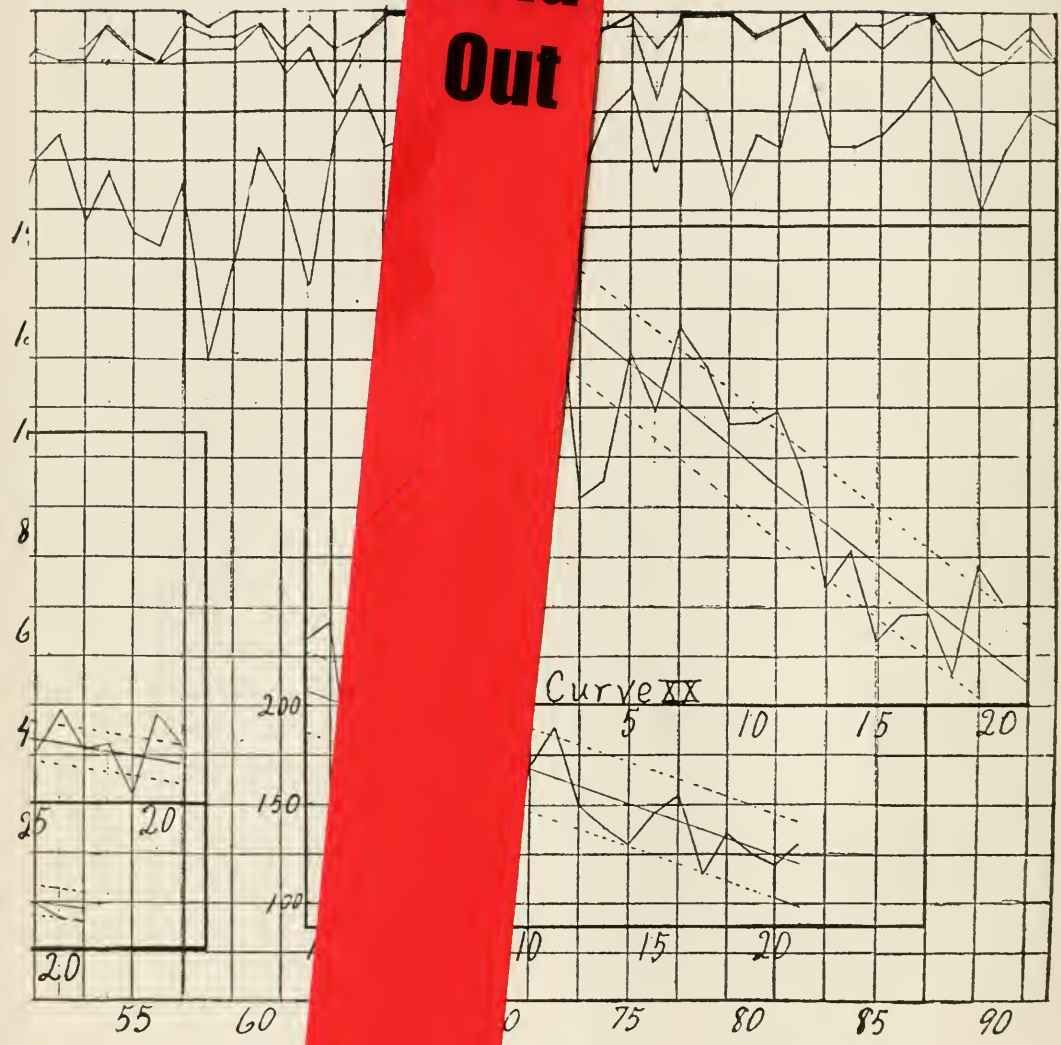

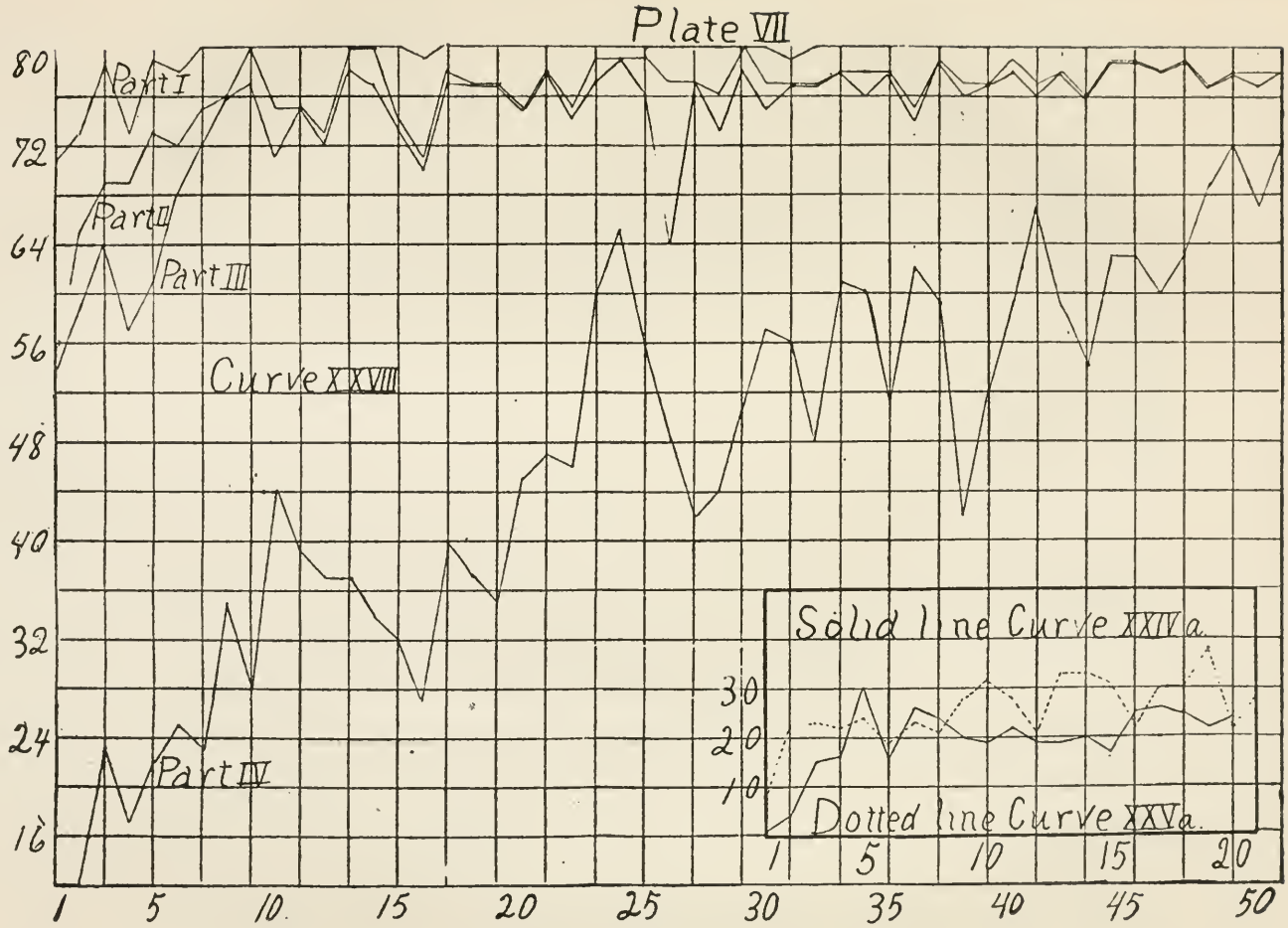
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Part I
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Curve XXVIII
Solid line Curve XXIV a.
Dotted line Curve XXV a.
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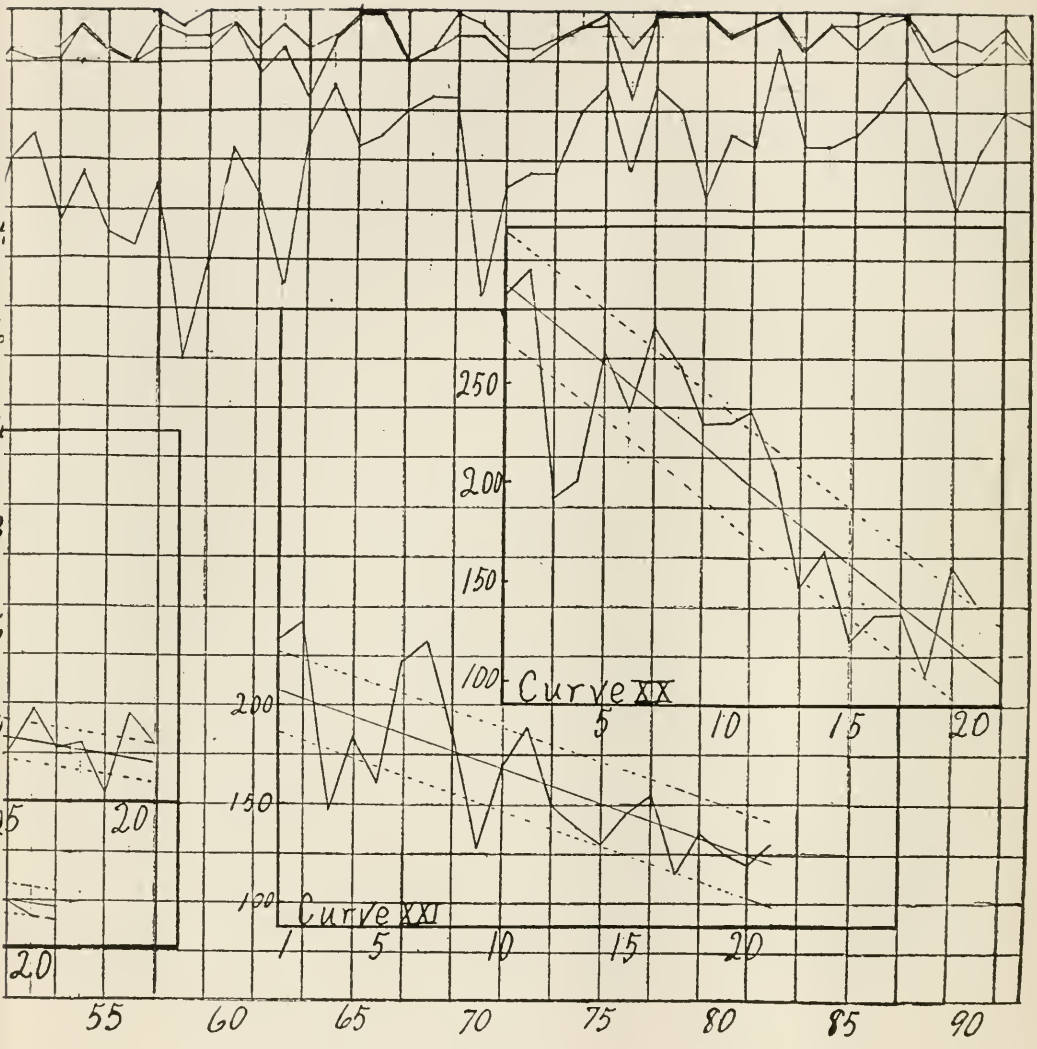
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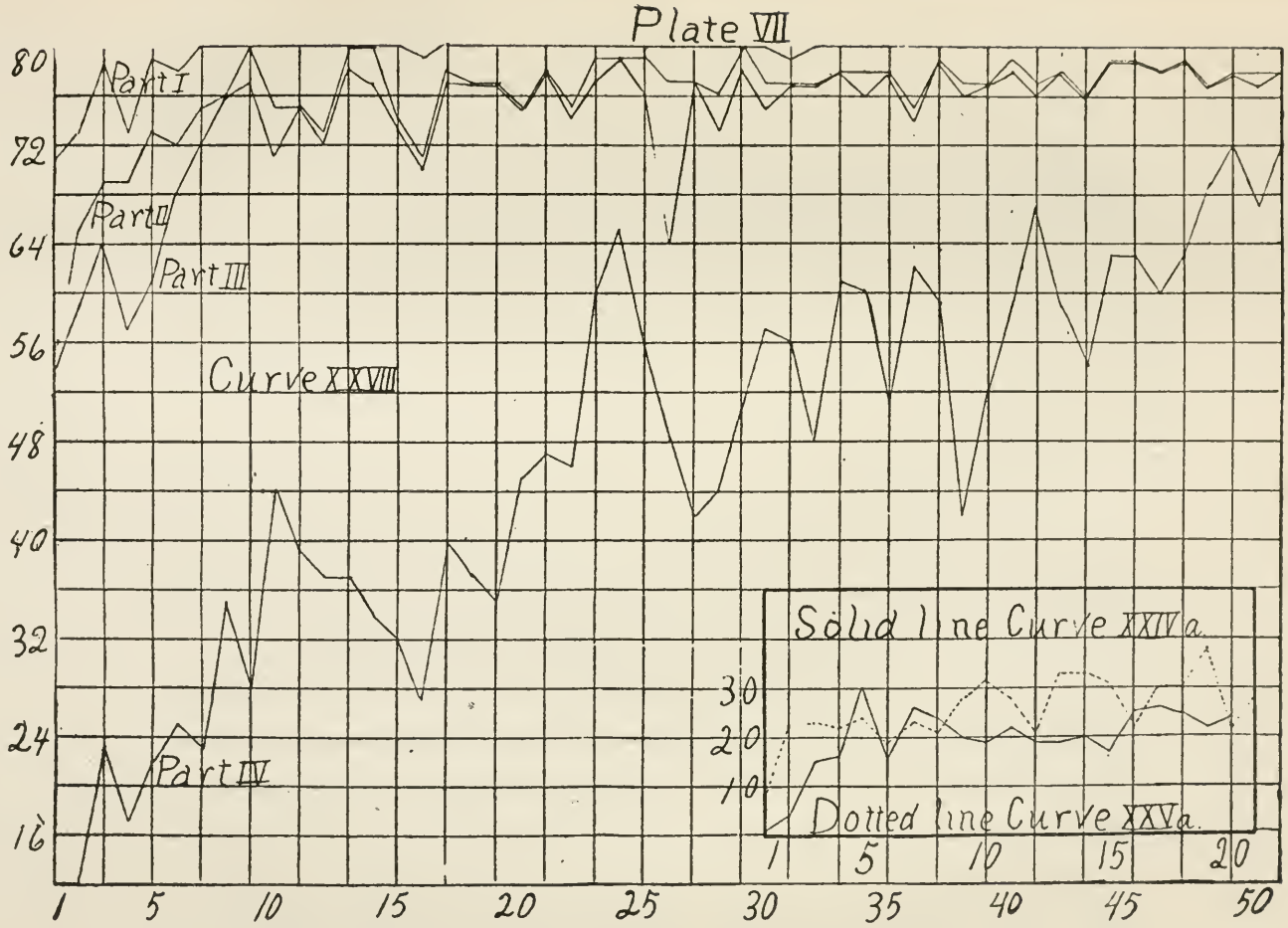
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Dotted line Curve XXV a.
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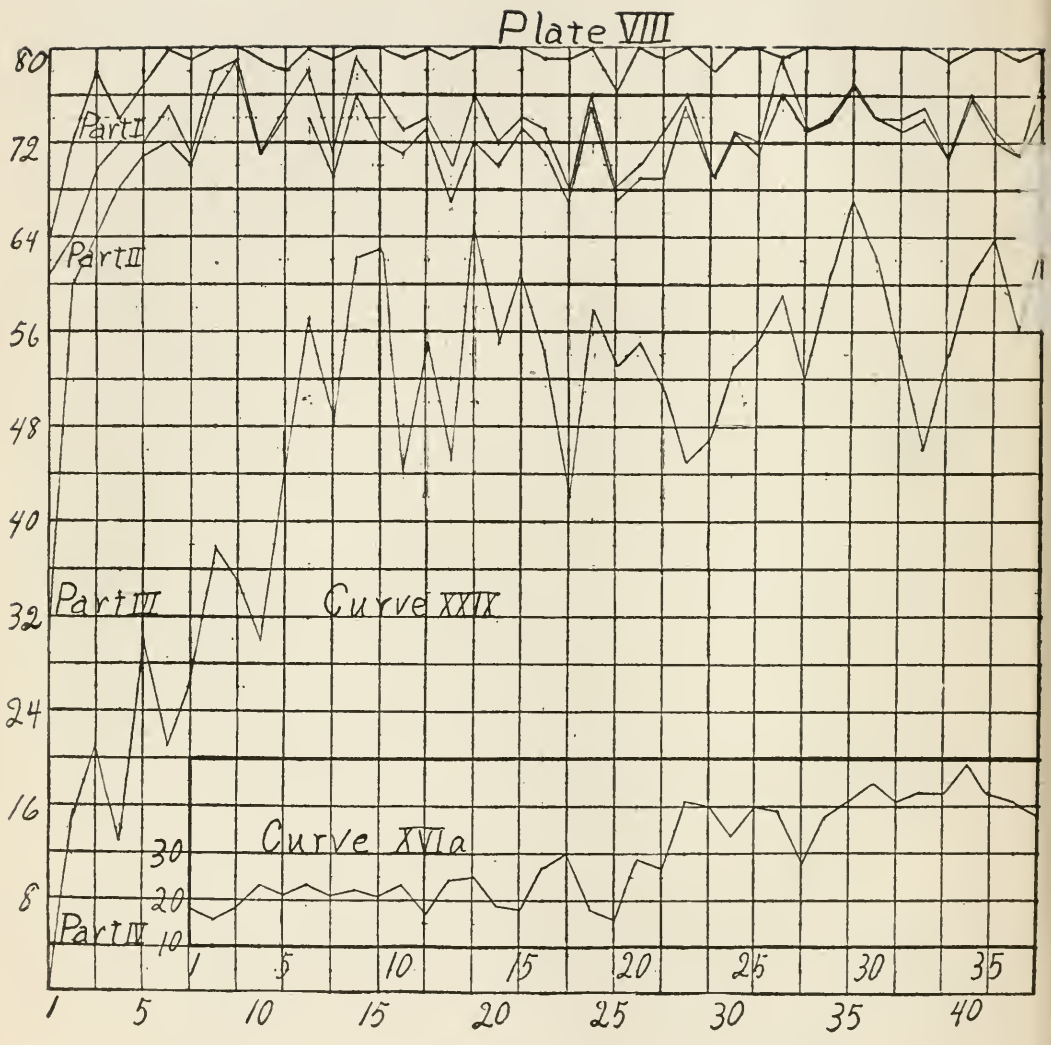
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Part II
Part III
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Curve XVIa
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