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AN EXPERIMENTAL STUDY OF THE DEVELOPMENT
AND
PERSISTENCE OF SKILL IN A COMPLEX MOTOR PERFORMANCE
With Emphasis Upon the Qualitative Aspects of the Problem

by

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INTRODUCTION

The problem of learning, sensory and motor, has been and is, constantly subjected to research. Since the rise of Gestalt theories the field of learning, and behavior generally, have undergone further intensive reexamination. In the light of Gestalt assumptions the results of numerous earlier studies and experiments are indicative of something different from the original interpretations and conclusions. As opposed to the older theories of learning which made the learning process a chance or mechanical thing, termed trial and error, the Gestalt concept as first formulated by Wolfgang Kohler, conceives all behavior as insightful and all learning as organized activity, directed toward some definite goal. Progress in every phase of learning is regarded as the resultant of growth, stimulation and maturation.

This experiment was undertaken with the general intent of making both a quantitative and qualitative study of the motor learning process, but specially of probing the qualitative aspects of motor learning insofar as the problem selected lent itself to such a study. This particular problem, the basis for a study of motor performance by Roff in 1930, was selected, because it was believed that it offered possibilities for further research, inasmuch as the qualitative factors had not been emphasized. Also, a number of the subjects used by Roff were available, which permitted of studying the stability of a motor pattern following a lapse of practice of about six months. The problem called for the hitting of a golf ball from a mat into an opening on an inclined plane a short distance away.

REVIEW OF LITERATURE

A survey of psychological literature quickly reveals the fact that the problem of motor learning in all its possible phases has been an interesting and fertile field of experimentation. The above statement needs modification only in that by far the majority of studies made are objective and quantitative in purport. While the method followed in not a few of the studies published has consisted of a combination of the subjective and objective, the conclusions have revealed but little with regard to the qualitative aspects of the motor learning processes of human subjects. It is possible that this lack of qualitative information may be due to the fact that the introspective method has been in disrepute and also because of the lack of subjects trained in structural analysis,

One of the earliest extensive learning studies to appear in the literature is that of Bryan and Harter (5). They noted that in the learning of telegraphy that the people under observation did not progress steadily until they reached their certain maximum; there were rather long periods before the maximum was reached when no progress was evident, with the study periods remaining the same. Following these stationary periods progress would begin again. The problem involved both rational learning and the acquisition of fine muscular coordinations. The work has historical significance in that it apparently proved that an occasional stationary period is inherent in the learning process. To what to attribute these periods of non-progress or plateaus has led to considerable controversy and various explana-

tions have been advanced. Rather recent experiments in attempting to clear up this very point of plateaus in learning have demonstrated that they may be induced anywhere in the learning process and are controlled by the distribution of work and rest. Lack of interest and monotony, which have been listed among the causes of plateaus, Wheeler (39) elects to designate as qualitative symptoms of irradiation. Further, in accordance with Snoddy's (30) conclusion, Wheeler states that plateaus are induced by faulty distribution of stimulation.

An experimental study of motor learning, one of the first extensive studies in this field, closely allied to the present one, was carried on by E. J. Swift (31). Swift was interested in the motor learning process, wished to determine the nature of the learning curve, and investigate the factors that induce variations in learning a motor problem. He selected for his problem ball-tossing. The task for five subjects was to toss and receive one ball while the second was in the air, using only the one hand. One subject used three balls and both hands. The balls were thrown and caught until one was missed, which constituted one trial. Each subject took ten trials daily and the score equaled the total number of catches made.

Swift observed early in the experiment that physiological changes influenced the subjects's performance. Strenuous effort was found to be effective only to a certain point, beyond this it was conducive to distraction and fail-

ure. Swift also concludes that confidence, interest, attitude, too much relaxation, intentional or otherwise, change of method or form, all were relevant to the outcome of a performance.

In interpreting the learning process as observed in this study Swift concluded that muscular coordinations are hastened in their development when the movements are accompanied by a feeling of pleasure, and inhibited when the accompanying feeling is displeasurable. Retentiveness is attributed to the leaving of traces in the nervous system. In a more recent paper Swift (32) proposes that learning follows from the growth of sub-cortical neural patterns and conditioned reflexes.

Swift's ball-tossing experiment has been repeated by others and many other similar motor learning studies have grown out of his pioneer work. Almost without exception the conclusions have been in accord with Swift's original interpretation, namely, that learning is facilitated when accompanied by pleasure and inhibited when accompanied by displeasure. Peterson's(25) ball-tossing experiment confirmed Swift's results. In plotting his results he found an almost complete absence of plateaus in both individual and average curves.

S. R. Braden (3) conducted an extensive experiment in motor learning and relearning to study the nature of the learning capacity in trial and error learning. He had his subjects toss small hard rubber balls at a circular hole

5 inches in diameter, 8 inches above the floor, from a distance of 12 feet. One day's practice consisted of 200 throws. Six practices a week were taken. The learning period consisted of 100 performances the first relearning period of 18 practices, 22 months and eleven days later, and the final relearning period closed with 18 practices, begun six months and 20 days after the first.

Braden observed that a high degree of concentration was required and that it was easy for the subjects to 'let down'. The scores revealed that improvement is rapid in retrials and that the second retrial shows a marked improvement over the first. No further interpretations are given.

Thorndike, (34) long prominent in the learning field, in a recent book comes out with a modification of his earlier explanation of the learning process. His present view apparently approaches in some respects the configurational hypothesis. In discussing learning he is less convinced than he formerly was that use of repetition in the sense of mere repeated sequences in time has any value. In order that connections may be strengthened by use mere sequence of time is not enough, there must be in addition, a certain 'be longingness'. Further, connections grow stronger when the after-effect is satisfying, and learning generally "is facilitated by identifiability of the situation and by availability of the response."

An interesting experimental study which has contributed to our knowledge of the motor learning process is Snoddy's (29) mirror tracing experiment. Significance lies in the fact that from observations made while his subjects traced

a six pointed star, guided by its reflection in a mirror, Snoddy was able to advance pertinent facts relative to the motor learning process. He found that his subjects did not move about haphazardly in attempting to trace the star, but that they imagined their paths at the outset. This short orientation period, during which the subjects were planning their future movements, was termed the 'period of initial delay'. Snoddy also observed that effort above a certain maximum induced so-called irradiation patterns in the neuromuscular organization, the development of the latter being essential for improvement in accuracy. His conclusions challenge the validity and the adequacy of the trial and error hypothesis as an explanation of maturation and improvement.

A forerunner to the present experiment was Roff's (26) study in the learning of a complex motor performance. His general purpose was to seek new facts on motor learning but specifically he desired to find out whether insight was an accurate description of the acquisition of skill in a motor performance, when the situation presented required a high degree of motor coordination and at the same time allowed individual freedom of action. The apparatus Roff used, his method and procedure have been basically incorporated in the present study.

In his final interpretations, Roff, describes the subject's performance not as random but as directed activity, as a unified total response, a purposive striving toward a goal, a resolution of tension. He further stated that

mere repetition of a performance unaccompanied by insight is futile. Because there exist in man potentialities of behavior and a 'forward reference' in neural mechanism as well, explains his ability to react more or less adequately to new situations(7).

In the brief reviews that have been made of studies involving the problem of muscular skill it is evident that in the majority, the assumptions underlying the work, either boldly made or intimated, were to the effect that at the beginning of the learning process movements are purely of a trial and error variety. The validity of these assumptions and laws is held very much in doubt by configurational psychologists and they offer a substitute theory. Slightly varying interpretations of the learning process as such are given by the different configurationists, however, they are mutually in accord in their challenge of the validity of all mechanistic and atomistic theories.

The outstanding champions of the Gestalt viewpoint today, Kurt Koffka (19) and Wolfgang Kohler (20 & 21) are strongly opposed to a genetic explanation of complex behavior as an accumulation or outgrowth of fairly specific stimulus-response bonds. The real data of experience are organized wholes or Gestalten; specific elements are not encountered in consciousness or behavior. All sensory data are to some degree integrated, organized, and as such may be responded to without previous learning. The responses are the functions of insight. No attempt is made to separate the sensory and motor processes, they function as components of a unified response. Utility and rhythm con-

tribute to the early success of a correct response in motor learning, while practice presents the necessary stimulation for the construction of more complex Gestalten. With maturation the organism is able to respond to more complex patterns or total organizations in the environment. It is emphasized that learning proceeds only when a situation involving a task is seen as a whole or entirety.

Further discussions of the Gestalt viewpoint are given by Hisao (15) and Helson (14). Their views in the main are in accord with the basic configurational principles.

The configurational hypothesis is interpreted and expanded in an interesting and convincing fashion by Wheeler (22). With reference to motor learning he suggests that muscular coordinations, (22, pp.310-311) "depend first upon the organism's perception of a goal....they are formed as the learner perceives the goal in its detail of spatial relation. Once the goal is established the organism is under tension, and the motor coordinations follow as a result of the tension, end-products of perceptual configurations." The formation of patterns is not attributed to insight, rather they are specifically conditioned by the stimulus arrangement. Learning of particular movements is accelerated when the time intervals are sufficient for the systems of nervous stresses induced to develop and mature. He further says that once the configuration is constructed, the movements take care of themselves.

Although there has accumulated considerable observational and experimental evidence within the past decade tending to clarify and substantiate the configurational

hypothesis open hostility to the theory, as such still is strong. Gestalt psychologists have been constantly widening their field of research and today believe that their concepts find universal application in every phase of learning and conscious behavior. The problem selected for the basis of the present thesis presented a complex situation in motor performance, and as such, it afforded a good example to which to seek to apply the current interpretations of motor learning or the theories regarding the acquisition of fine muscular coordinations.

DESCRIPTION OF APPARATUS

Though in the main the apparatus used in this experiment is that constructed by Roff(26), certain important modifications were made. His description in substance follows: The apparatus consisted of a golf club with a pitch of 45 degrees, two golf balls, a cocoanut mat from which ball was played, and an inclined plane of canvas, 6 feet 6 inches by 4 feet, with a hole 14 by 16 inches in the center. The plan of the plane and its backstop is illustrated by the accompanying blue print. The plane was a wooden frame covered with tightly stretched canvass; on the back end was a similarly constructed back-stop, rising 3 feet 8 inches above the plane, the upright of which supported the plane. On the front end was a net of canvas 18 inches high, the frame of this supported the lower end of the plane at a height of 10 inches. Strips of wall board 6 inches wide closed the sides of the plane and kept the balls from rolling off. At the lower end of the plane, lying on the canvass, was a 1 inch board running the width of the plane, 7 inches wide on the left side tapering to a point at the right to a hole in the side-board leading to runway. Nailed perpendicular to this board was a strip of wall-board 8 inches in width to prevent the ball from rolling off the plane when it did not hit the hole, and to deflect the ball to the runway. The top of this was 20 inches from the floor.

Under the hole was a wood box, tilted to the right front so the ball would roll out into a short runway connecting with a main runway, a wooden trough 3 inches wide,

4 inches deep, and 8 feet long, which led the ball from the plane to the mat. Canvass was stretched from the edge of the hole to the box to prevent escape of the ball. In particular the changes made consisted of two different sized interchangeable frame openings, the inner dimensions of the one 14 by 16 inches, corresponding in size to the original used by Roff, while the second was half again the area of the first with the dimensions kept in the same proportion. The openings were made by nailing together in each case, two rectangular skeleton frames of lightwood, with canvass stretched tightly over the top. Both of the frame openings fitted snugly into the opening cut in the inclined plane and were flush with its surface. Since the main runway was too short to bring the balls back to the teeing-off mat at the farther distance, a very simple chute with a deflector was constructed to lead the balls onto the mat. The first part of the experiment was conducted inside a curtained off corner beside a stairway in one of the basement halls. For the second part the apparatus was moved into a room then available.

SUBJECTS

Two groups of subjects were used in this experiment, thirteen people in all; in the first part seven subjects, three women and four men, as many as were available of those who served for Roff. Two of these were professors of psychology, namely, Dr. Beulah M. Morrison, #2, B.M.M.; and Dr. Raymond H. Wheeler, #1, R. H.W.; three men, F. Theodore Perkins, #3, T.P.; Byron Sarvis, #4, B.S.; and Cree Warden, #5, C.W.; were graduate students in psychology, and the two remaining, Sue Ganson, #6, S.G.; and Elnora Johnston, #7, E.J., were academic seniors, majoring in psychology. As already indicated these people had all served as subjects in Roff's experiment and were used here after a lapse of about six months, in an attempt to check the stability of skill or pattern in a complex motor act and, at the same time to secure as much introspective data as possible on the relearning process.

For the second part of the experiment six new people were used. Donald F. Showalter, #11, D.F.; and Robert L. Brigden, #8, R.B., were graduate students in psychology. Myron G. Messenheimer, #9, M.M., was an academic senior majoring in psychology. The three others, Ned Russell, #10, N.R., William F. Blair, #12, W.B., and Andrew H. Panettiere, #13, A.P., were under-graduates in the college. None of this group had ever served as subjects in a motor learning experiment of this type, nor were any accomplished

golfers, although a few had played some golf and knew something of proper golf technique. No instructions were given to any of the subjects relative to stance, gripping of club, use of wrists, and the like.

PROCEDURE

The procedure followed was much the same as that employed by Roff, due in part, to the fact that the first group of people were being studied for stability and rapidity of relearning, thus the original conditions, insofar as possible, were kept constant. One performance consisted of 100 trials, subjects practiced either two or three times a week, Sundays disregarded. Those performing three times a week generally did so on Monday, Wednesday, and Friday, while those shooting twice a week usually shot on Tuesday and Thursday, although there was considerable irregularity on the part of a few for various reasons. All the subjects were started at the same distance and shot for the same target, the total number of practices varying from eight to twenty-one. The time taken for a complete performance, 100 shots, varied from ten to thirty minutes. The majority of this first group started practicing in the first week of November, a few the second week. They shot with the ball three yards from the hole until the middle of December, when they were moved back to a distance of $4\frac{1}{2}$ yards and were given for their new target an opening one-half again as great in area, dimensions in the same proportions. At this farther distance, the subjects took from two to six practices, which closed the first part of experimentation proper.

In the second part of the experiment the procedure was changed in some particulars. Of the six new subjects, three

were started on the problem at the three yard distance, with the smaller hole as target, while the others were started at the $4\frac{1}{2}$ yard distance, with the larger opening as target. As already explained the areas of the openings were proportional to the distances. As in the first part of the experiment not all the subjects performed an equal number of times per week, and further, not all took 100 trials during a period. Three of the six took 100 trials three times a week on regular days, Monday, Wednesday, and Friday, and of the other three, two took 100 and one 50 or 100 trials twice a week on irregular days. Two reasons for not conforming to an absolute regularity of practice and a definite number of trials may be given. In the first place the time factor had to be considered, both as far as the subjects and the experimenter were concerned. Since the subjects gave of their services for a period of several months 2 and 3 times a week this was important. In the second place there was no particular reason for all of the subjects to adhere to the same schedule of time of practice, number of practices, and number of trials per period. A variety of conditions were welcomed inasmuch as the qualitative factors were to receive special emphasis.

During the first part of the experiment, which was conducted in a curtained off corner in the corridor, the experimenter sat facing the rack, in a position somewhat to the rear and right of the performer. When the apparatus was moved into a room for the second part of the experiment the experimenter sat facing the rack a little distance to

the left and front of the subject. Throughout the experiment a complete record of every performance was kept on scoring sheets. The hits were counted, and by a system of symbols a record was kept of the landing place of the ball when it failed to hit into the box. To facilitate rapid and accurate charting of all shots that missed the target, the canvass was divided into 4 zones by chalk lines. Zone one comprised the area within 1 in. of the edge of the hole, zone two the area between 1 and 3 in., zone three the area between 3 and 8 in., and zone four the remaining or peripheral area on the inclined plane. Balls falling short, above, and off the side of the rack were all counted as, off rack. Dispersion charts drawn to scale with shots plotted by half periods appear in the section on individual results. The portions of areas of the charts inclosed by dotted lines below and above, represent the front base and the upper rear screens, respectively. All wild shots, balls sliced, topped etc., that failed to light on the plane, are plotted in either one or the other of these two areas.

Thorough introspections while desired were very difficult to obtain. The subjects were encouraged to volunteer information and make oral comments during the trials. Spontaneously given they were not a great distraction. They were always interesting, and expressed personal reactions more definite than did more formal replies to questions. The subjects were however, often interrupted and questioned

relative to possible factors considered relevant or detrimental to the learning process. As a group the people used were not trained in structural analysis. As Roff indicated the continual halting of the subject during a performance seriously affects the quantitative results, due to the fact of interrelationship between shots. Some few of the subjects kept up an intermittent conversation while shooting, however the majority generally waited until a break in the performance, or until the end, before they volunteered such information or tried to answer questions. Some performances were more hurried than others, perhaps due to press of duties or to the shortness of time able to be given to the task.

The experimental conditions for the first part were very unsatisfactory, at least from the standpoint of the sensitive subject. The performances were rather often subject to interruptions of various kinds such as, people or classes passing, indulging perhaps in loud conversation; people stopping to view the performance, which upset some of the subjects greatly, or else in anticipation of an audience the subject would be in a constant state of apprehensive tension. The failure of some subjects to reach their earlier marks may be attributed to the unsatisfactory conditions under which the experiment was continued. For the second part of the experiment the conditions were good and the performances almost free of interruption.

The attitude of both groups of subjects was commendable

throughout the experiment. Those comprising the relearning group were all interested, especially in the beginning, concerning their probable retentiveness and the time or number of practices necessary to reach or exceed their earlier maximum performances. The men compared their scores and at times rather a competitive and speculative spirit was apparent as they sought to outscore each other or reach at least a specific minimum score. During the second part of the experiment the same feeling prevailed among the subjects. The scores were posted every week for all to see and curves of their respective performances were maintained continuously on the blackboard, enabling each one to note at all times his relative position and progress.

RESULTS

The results are divided into two sections, individual and general, the latter is given over to explanation and detailed discussion. The immediately following section contains individual introspective data with comments by the experimenter and results in graphic and tabular form for each subject. The data for the relearning group appear first. The individual observations by the different subjects bring out important features in the learning process that may not be adequately emphasized otherwise.

TABLE I

1, R. H. W. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

: No. and : date	: total: : hits:	: hits: : 1st:	: hits: : 2nd:	: % 1st: : zone:	: % 2nd: : zone:	: % 3rd: : zone:	: % 4th: : zone:	: % off: : rack:
: Samples of subject's performances as recorded by Roff :								
: 2. 11/27	48	42	54	12-20	12-16	20- 6	8- 2	6- 2:
:18. 3/6	68	64	72	12-12	6- 4	- 8	8- 4	- :
:56. 6/16	85	84	86	4-10	8- 2	- 2	4-	- :
: Present relearning record at distance of 9 feet :								
: 1. 11/5	67	58	76	16- 6	16-12	6- 4	4- 4	4- 2:
: 2. 11/7	76	76	76	6- 8	16-10	2- 6	-	- :
: 3. 11/10	63	48	78	12- 4	22-10	14- 6	-	4- 2:
: 4. 11/12	75	74	76	8- 6	16-10	2- 4	4-10	2- 4:
: 5. 11/14	56	56	56	10-12	14- 4	6- 6	4-10	6-12:
: 6. 11/17	55	56	54	10- 6	18-20	14-20	4-	4- :
: 7. 11/21	85	78	92	8- 4	8- 4	2-	2-	2- :
: 8. 11/24	71	68	74	10- 6	12-14	6- 6	2-	2- :
: 9. 12/3	71	64	78	10- 8	8-10	6- 2	8- 2	4- :
:10. 12/5	67	64	70	10- 6	12-14	6- 8	4-	4- 2:
:11/ 12/8	78	70	86	14- 4	10- 6	4- 2	2- 2	- :
: Averages	63	59	68	11- 6	13-10	6- 5	2- 1	3- 2:
: Moved back to 13 $\frac{1}{2}$ feet :								
:12. 12/17	42	44	40	6-14	16-22	12-12	10-10	12- 2:
:13. 12/19	58	56	60	14-16	20- 8	2-12	4- 2	4- 2:
: Averages	50	50	50	10-15	18-15	7-18	7- 6	8- 2

No of Correct Shots and Gross Errors

100
90
80
70
60
50
40
30
20
10
0

— Original learning curve
- - - Relearning curve
— Original gross error
- - - Relearning gross error

5 7 10 12 14 17 21 24 3 5 8
November December

Dates of Practice Periods
for relearning

#1. R. H. W. I





#1 R.H.W. II

Practice Periods

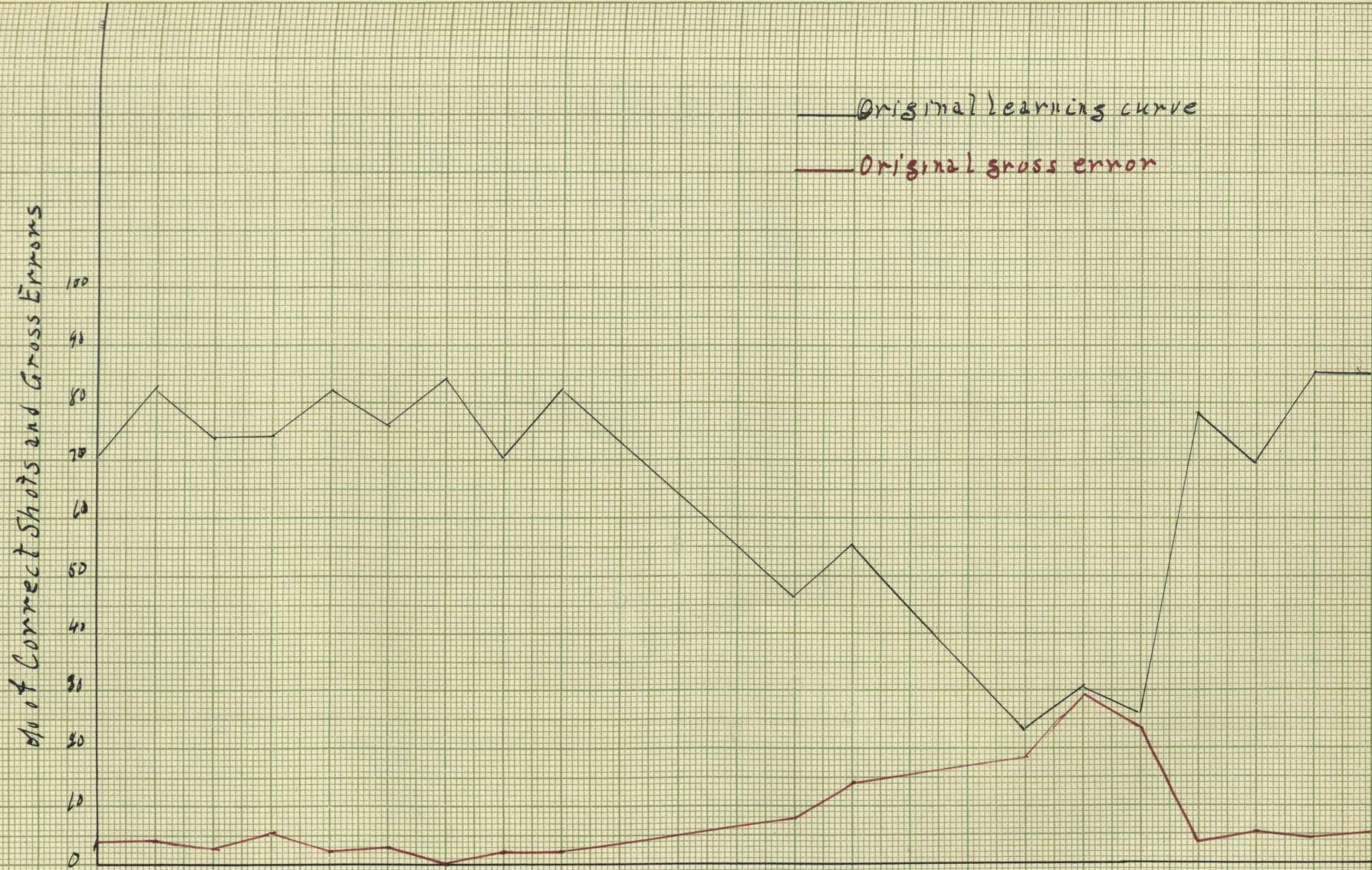
of Correct Shots and Gross Errors

— Original learning curve
— Original gross error

100
90
80
70
60
50
40
30
20
10
0

Practice Periods

#1 R. N. W. II



DAILY RECORD SHEET

<u># 1, R. H. W.</u>	<u>11/17/30</u>	<u>6</u>	<u># 55</u>
subject	date	no.perf.	hits-H
1. H	26. H	51. H	76. H
2.	27. H	52.	77. H
3. H	28. H	53. H	78. H
4. H	29.	54.	79.
5.	30. H	55. H	80. H
6. H	31.	56. H	81. H
7.	32. H	57. H	82.
8. H	33. H	58.	83.
9.	34.	59.	84. H
10.	35.	60.	85.
11.	36. H	61. H	86. H
12. H	37.	62.	87.
13. H	38.	63.	88. H
14.	39.	64.	89. H
15.	40. H	65. H	90. H
16. H	41. H	66. H	91.
17. H	42.	67. H	92. H
18. H	43. H	68. H	93.
19.	44. H	69.	94.
20. H	45. H	70.	95. H
21.	46.	71. H	96.
22. H	47. H	72.	97. H
23.	48. H	73.	98. H
24. H	49. H	74.	99. H
25.	50.	75. H	100.

INDIVIDUAL PERFORMANCE

#1, R. H. W. had not practiced any since the close of the experiment about six months before. As a glance at table I will reveal, this subject had done remarkably well under Roff, even though not adhering to regular practice periods. His first retest score was 67. The lapse of time since his last practice seemingly had not impaired his skill. He said, "I find it relatively easy, the pattern is stable--know just what to do." The new location in which the experiment was conducted did not bother him. The time between shots, he felt was too long, "I often lose the correct tension between shots." Twenty-one hits were scored out of the first 25 attempts. No apparent necessity for warming up. This subject shot below his initial score but 3 times out of 11 practices, which were irregular. In sum considerable improvement is evident.

It should be noted that this subject had played golf for a number of years, played the game well, and understood proper golf technique. His stance and method of shooting varied considerable from that of the less experienced subjects. He stood with feet apart, head⁺shoulders well forward and over the ball, gripped the club low, and hit the ball with a short quick swing. He took very little time to spot the ball, often hitting it from where it came to rest. His stroke was free, regular, and rhythmical. He played the balls rapidly and completed his practice in as little as ten minutes time.

During his second practice he said, "I'm altogether

off form haven't the pattern can't hold it." Score 13 below previous one. Third practice. Comment following a bad start, "I just can't get tightened up." Shot 75, a new high score. Fifth practice: following an erratic series, he said, "Haven't the right tonus- -no swing- -can't marshall forces." After a short shot, "Had feeling it would be short." November 17, "Tension was resolved vocally. I'm completely off my game. Stroke too tight, can't get into a rhythmic swing." Comment was made to the fact that adjustments are made on the basis of a general pattern, a tension that resolved itself into a successful stroke. Seventh practice, shot his best score. "I felt less distracted than at times previously. The pattern was clear and easily recovered following a miss. Concentrated but not at very great effort." Eighth performance. "Lack tenseness- -takes too much effort." Takes a little time to recover correct pattern." Toward close of period, "Held to pattern with scarcely any effort." Final practice at short distance. "Missed due to over-excitement- -too animated. Feel peppy, although a little stiff. Believe I'll shoot above my last score." Shot 78, eleven over last score.

Upon being moved back to the $4\frac{1}{2}$ yard distance his score fell off considerably. Shooting from the farther distance presented an enlarged stimulus pattern, called for more energy and allowed a different kind of shot. This subject was well able to adjust himself to the new situation however. Practically the same stance and form were retained.

TABLE II

2, B. M.M. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits: 1st 1/2	hits: 2nd 1/2	% 1st zone	% 2nd zone	% 3rd zone	% 4th zone	% off rack
Samples of subject's performances as recorded by Roff								
2. 1/16	28	34	22	6-10	16-14	12-12	12-18	20-24
16. 3/13	48	48	48	16-14	20-18	6-10	6- 4	4- 6
28. 4/24	62	58	66	10- 6	14-14	10- 8	4- 4	4- 2
Present relearning record at distance of 9 feet								
1. 11/12	37	30	44	6- 4	14-10	14-18	12-20	24- 8
2. 11/14	44	38	50	14- 4	14-10	16-16	6-10	12-10
3. 11/17	30	24	36	8- 6	16-16	18-10	16-22	18-10
4. 11/19	36	40	32	6- 8	16- 8	10-26	12-14	16-12
5. 11/21	49	54	44	8-12	6-12	16-18	6- 8	10- 6
6. 11/24	50	40	60	8- 6	12- 6	10-10	12-10	12- 8
7. 12/1	44	36	52	6- 8	6- 4	16- 8	20-18	16-10
8. 12/3	42	26	58	16- 4	20-20	6- 8	20- 8	12- 2
9. 12/5	33	36	30	10-10	16-14	16-10	10-24	12-12
10. 12/8	38	36	40	6- 4	16-10	16-24	18-12	8-10
11. 12/10	45	40	50	14- 6	12-10	8-12	18-12	8-10
12. 12/12	41	44	38	20-18	10-20	2- 2	12-12	12-12
Averages	40	37	44	10- 7	11-11	11-13	13-14	13- 9
Moved back to 13 1/2 feet								
13. 12/15	18	12	24	6-10	12-16	28-10	30-18	12-24
14. 12/17	24	18	30	6- 6	18-10	16-14	22-36	20-20
15. 12/19	31	34	28	10- 6	6-22	12- 8	10-24	18-12
16. 1/5	20	22	18	10-16	22-10	18-12	16-20	12-22
17. 1/7	33	20	46	10- 8	10-12	18- 8	20-18	22- 8
18. 1/9	32	18	46	8-12	12-10	22-12	16-10	24-10
Averages	26	20	32	8- 9	13-10	19-11	19-18	20-18

% of Correct Shots and Gross Errors

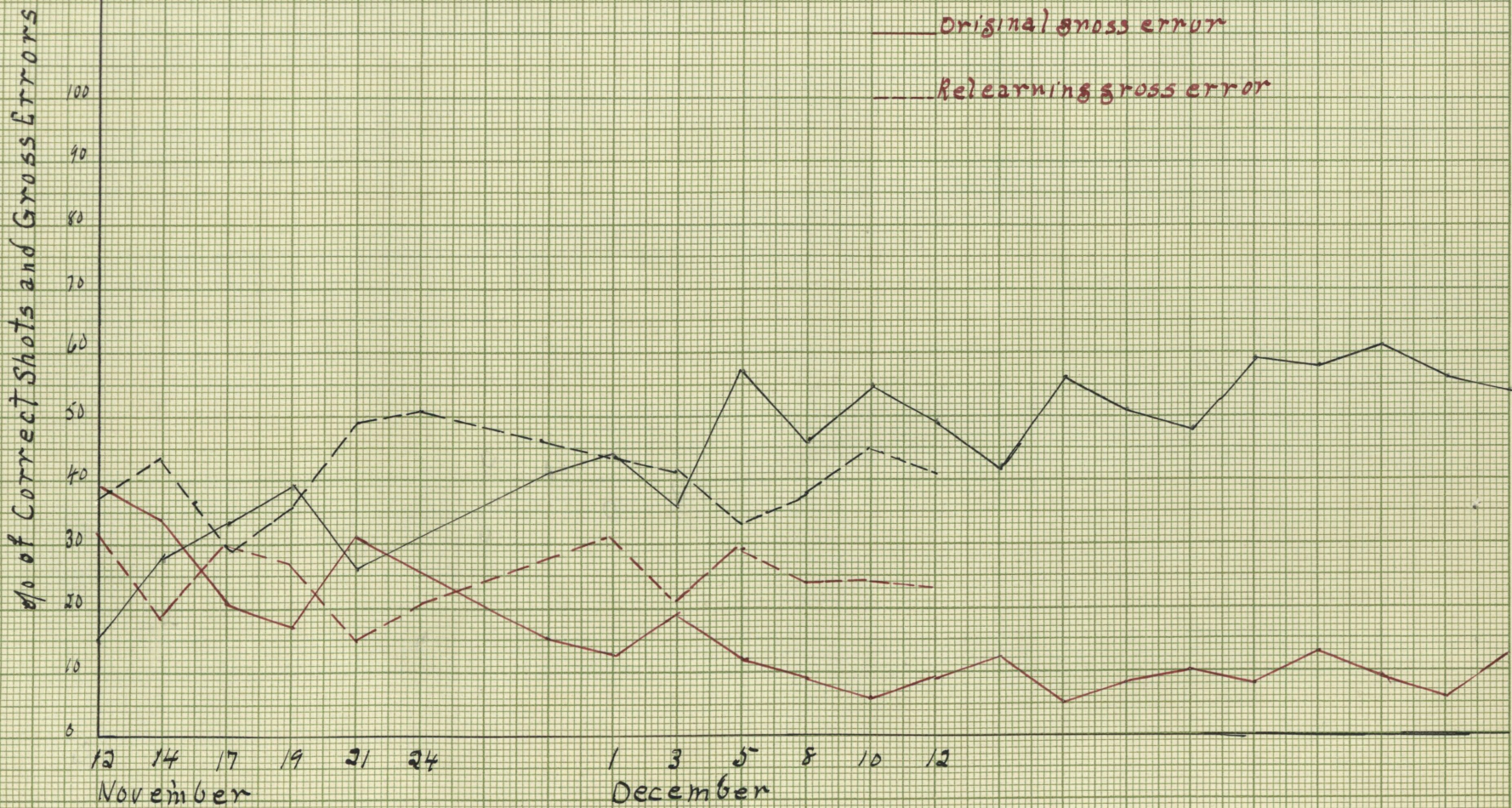
100
90
80
70
60
50
40
30
20
10
0

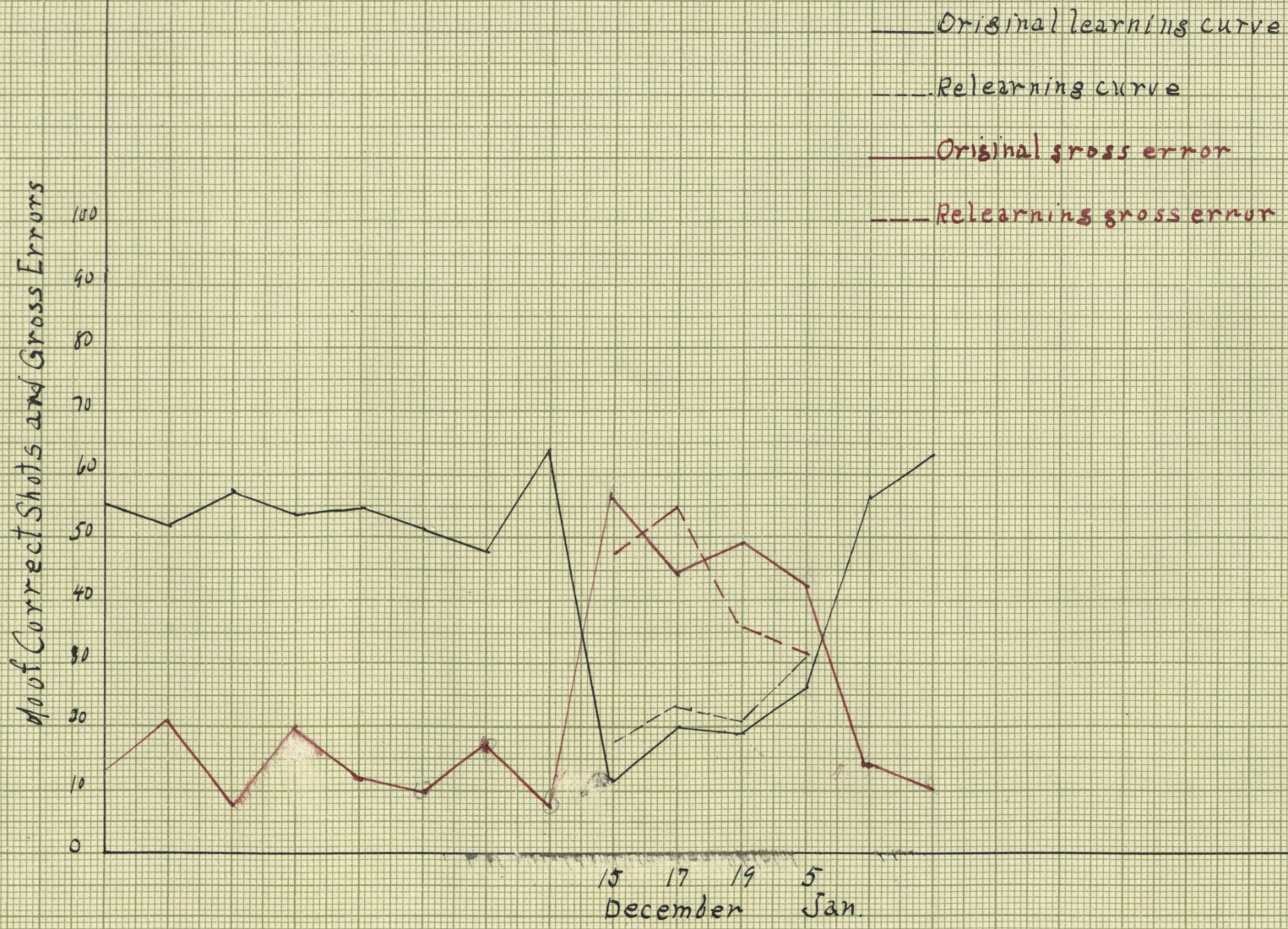
12 14 17 19 21 24 1 3 5 8 10 12
November December

Original learning curve
Relearning curve
Original gross error
Relearning gross error

Dates of Practice Periods
for relearning

#2 B.M.M.I





Dates of Practice Periods
for relearning

#2 B.M.M. II

DAILY RECORD SHEET

<u># 2, B. M. M. 11/24/30</u>		<u>6</u>	<u># 50</u>
subject	date	no. perf/	hits-H
1.	26.	51.	76. H
2.	27. H	52.	77.
3.	28.	53.	78.
4.	29.	54. H	79.
5. H	30. H	55. H	80. H
6.	31. H	56. H	81.
7. H	32.	57. H	82. H
8. H	33.	58.	83.
9 9 .	34.	59. H	84.
10. H	35. H	60. H	85. H
11. H	36. H	61.	86. H
12.	37. H	62.	87. H
13. H	38.	63. H	88.
14.	39.	64.	89.
15.	40.	65. H	90.
16. H	41.	66.	91. H
17.	42. H	67. H	92.
18.	43. H	68. H	93.
19. H	44. H	69. H	94. H
20.	45.	70. H	95. H
21.	46. H	71. H	96. H
22.	47.	72. H	97. H
23.	48. H	73. H	98.
24.	49. H	74. H	99. H
25.	50.	75. H	100. H

#2, B.M.M. Her first practice since close of experiment in spring. She took 3 practices a week on Monday, Wednesday, and Friday. In commenting upon her first practice this subject stated that she knew just what to do but was unable to get the required coordination. After a few shots had been taken she discovered that the club was held incorrectly, eyes were raised too soon, and the stroke choppy because of the shortness of the swing. There would be short periods when the pattern would assert itself and then again vanish. She said, "The best performance is a very smooth one, it has no particular tenseness. Good shots are rhythmic, they are easily felt, however not all good shots lead to a score."

This subject's initial relearning score was much below her final mark of the spring before, which she failed to reach during the learning period. The conditions under which the problem was continued did not seem to be favorable. While not exactly nervous, this subject was disturbed by extraneous factors such as, loud talking, people walking past, and by spectators. She practiced the first hour in the morning which may be of significance. She was constantly analyzing her strokes and trying to remedy mistakes. Her stroke ordinarily was long, free, and regular. While using two balls she nevertheless waited for the second one to return to the mat before commencing her stroke. Her comments are interesting.

Third practice. "I must do less thinking about my performance. I can't hold to correct form--the pattern

won't stay. Can't seem to regulate energy to maintain proper tension." Later, "The second ball bothers me, I can't shoot until it lands on the mat or stops rolling. My energy is totally unorganized with reference to the target, I'm not sufficiently relaxed." Somewhat disturbed by spectators. After vacation. "Must get the distance, can't keep from hitting too hard- -can't explain it. Improvement does not always follow with greater efforts. Overtrying is detrimental." December 3. "Know what to do but can't hit as I ought." She started to shoot with more abandon, hit more consistently immediately. Outcome of greater relaxation it is reasonable to conclude. Dec. 5, "Feel rather tired. Takes more time to get into proper form- -pattern slower to develop. Hurrying often leads to a poor shot that might otherwise have been good."

Following shift to farther distance. "Need to get the distance, Don't seem to be able to regulate the energy to put into the stroke." Taking the score as indication the farther distance presented a much more difficult task to this subject. While she very evidently profitted by her earlier practice her improvement was very slow. This subject, and all the others as well, shot less rapidly at the farther distance. Third practice at longer distance: "Longer distance is more sporting." After vacation: "Dont know just how hard to hit. Pattern at longer distance seems harder to get but easier to realize when present. Proper pattern unmistakable, can be told and felt, it almost stands out." Later, "Learning is certainly not due to formation of set pathways, otherwise there would be less variance in scores and instability of patterns."

TABLE III

3, T. P. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

: No. and : date	: total: : hits:	: hits: : 1st:	: hits: : 2nd:	: % 1st: : zone:	: % 2nd: : zone:	: % 3rd: : zone:	: % 4th: : zone:	: % off: : rack:
: Samples of subject's performances as recorded by Roff :								
: 3. 1/3	27	26	28	14- 6	8- 8	10-10	28-36	14-12:
:13. 3/28	47	36	58	18- 6	16- 6	8- 4	14-20	8- 6:
:22. 4/23	70	60	80	12-12	10- 4	8- 2	6- 2	4- :
: Present relearning record at distance of 9 feet :								
: 1. 11/4	67	64	70	6- 4	12- 8	8- 6	2- 6	8- 6:
: 2. 11/7	49	40	58	8- 8	18-10	12-12	12- 6	12- 4:
: 3. 11/8	51	60	42	4-14	14-12	8-14	2- 4	14- 6:
: 4. 11/11	55	62	48	6- 8	10-14	8-18	6- 6	8- 6:
: 5. 11/14	43	44	42	10-10	12-10	14- 8	6- 8	14-16:
: 6. 11/18	55	58	52	8-10	14-18	10-10	8- 8	2- 8:
: 7. 11/21	59	56	62	8- 6	10-10	12-14	4- 10	8- 8:
: 8. 11/25	59	54	64	12-10	16- 6	12-10	4- 2	4- 8:
: 9. 11/28	49	48	50	12-14	24-16	- 8	4-10	12- 2:
:10. 12/3	54	54	54	16- 8	20-20	2- 6	4- 6	4- 6:
:11. 12/6	62	62	62	6- 8	18-16	4- 4	6- 2	4- 8:
:12. 12/9	69	66	72	10- 4	18-12	- 4	2- 4	4- 4:
:13. 12/10	57	56	58	6-10	16-12	4- 6	10- 8	8- 6:
:14. 12/12	66	72	60	12-24	4- 6	-	8- 4	4- 6:
: Averages	56	52	56	8-10	14-12	6- 8	5- 5	7- 6:
: ** Moved back to 13½ feet :								
:15. 12/16	41	36	46	14-12	22-16	14-10	6- 6	4-10:
:16. 12/19	42	34	50	10- 8	16-14	8- 8	12- 6	20-14:
:17. 12/22	36	34	38	10- 6	20-16	12-16	14- 8	10-12:
:18. 1/2	32	24	40	10-16	18-12	22-14	14- 8	12-10:
:19. 1/6	43	36	50	10-12	20-12	24-12	4- 6	6- 8:
:20. 1/8	46	48	44	10- 6	16-14	14-16	6-14	4- 6:
:21. 1/13	48	48	48	14-12	20-10	4- 2	8-18	6-10:
: Averages	41	37	45	10-10	18-12	14-11	9- 9	9-10

— Original learning curve
 — Relearning curve
 — Original gross error
 - - - Relearning gross error

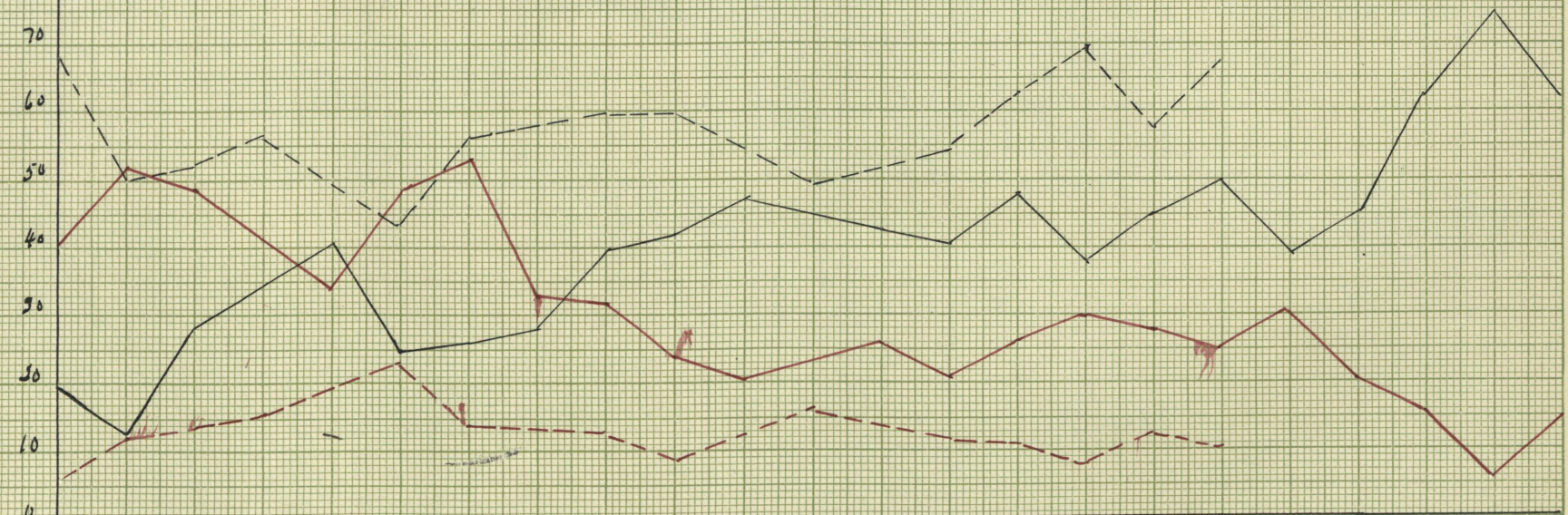
No. of Correct Shots and Gross Errors

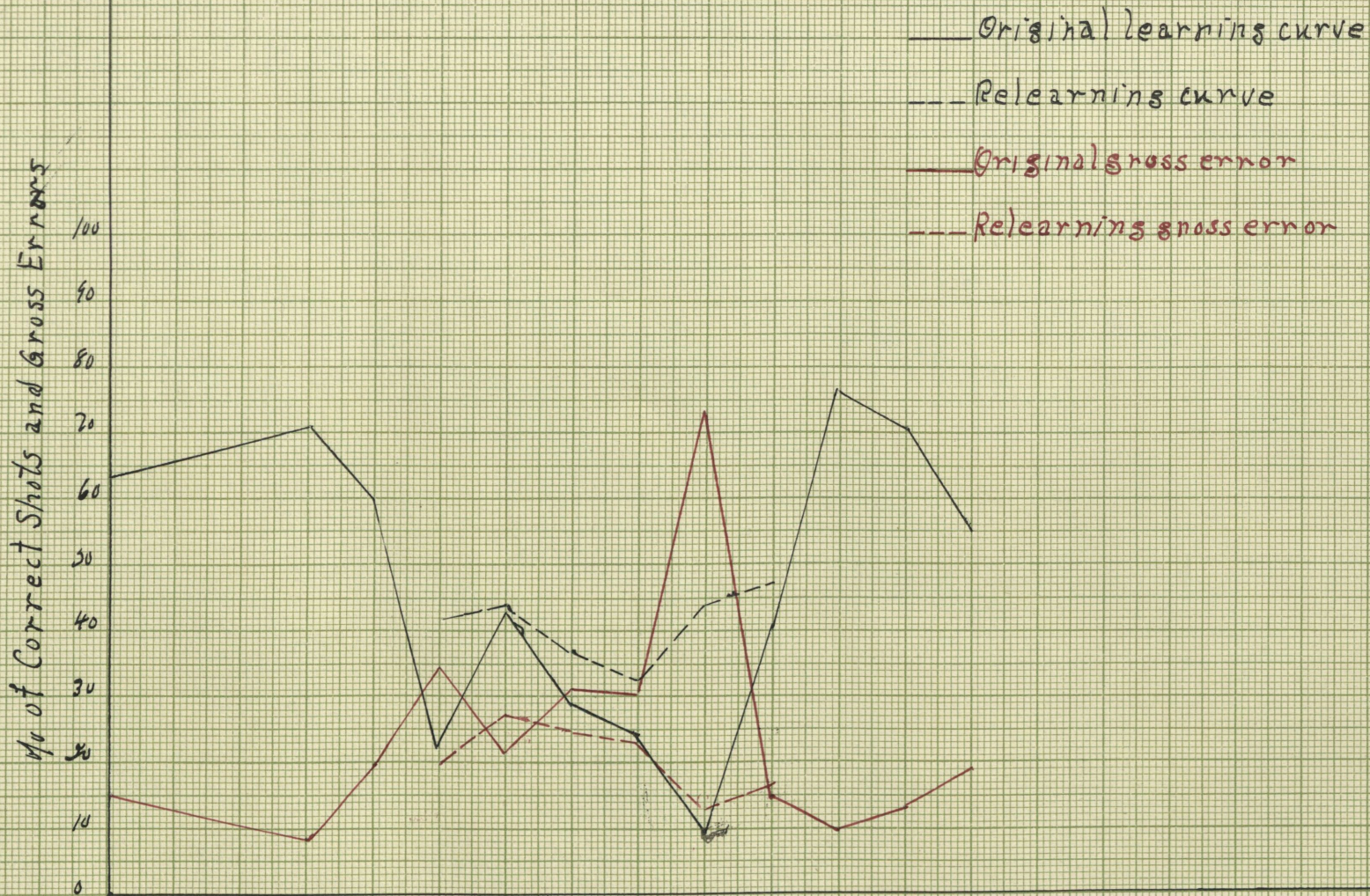
100
90
80
70
60
50
40
30
20
10
0

4 7 8 11 14 18 21 25 28 3 6 9 10 12
November December

Dates of Practice Periods
for relearning

#3 T.P. I





16 19 22 25 28 31
 December January

Dates of Practice Periods
 for relearning

#3 T.P. II

DAILY RECORD SHEET

<u># 3, T. P.</u> subject	<u>11/28/30</u> date	<u>9</u> no. perf.	<u># 49</u> hits-H
1. H	26.	51.	76. H
2.	27.	52. H	77. H
3. H	28. H	53.	78.
4. H	29.	54.	79. H
5.	30. H	55. H	80. H
6. H	31.	56.	81.
7. H	32. H	57. H	82.
8.	33.	58. H	83.
9.	34. H	59. H	84. H
10. H	35. H	60. H	85. H
11.	36.	61. H	86. H
12. H	37.	62. H	87.
13.	38.	63. H	88. H
14.	39. H	64.	89.
15.	40. H	65.	90.
16. H	42. H	66.	90.
17.	42.	67.	92.
18. H	43. H	68. H	93.
19.	44. H	69. H	94.
20.	45. H	70. H	95. H
21.	46. H	71. H	96.
22.	47.	72.	97.
23.	48. H	73. H	98.
24. H	49. H	74.	99. H
25.	50. H	75.	100.

#3, T.P., was one of the highest scores in Roff's experiment. He found the situation not at all difficult to readjust to even after the long lapse. He shot a score of 67 at his first retest, above the average of his later scores and at least equal to his average mark made in the spring before. This subject had played some golf during the summer vacation. His stance and swing conformed more or less with conventional golf procedure. Since the apparatus had been constructed for right handed people, this subject, being left-handed, was required to bring the ball upon the mat, after it left the run-way. Most of the time he stooped down and placed the ball into the desired position with his hand. His stroke was regular, rhythmic, and well coordinated as a rule. He was often disturbed by spectators, and following their departure a visible 'let down' was at times evident. Maintaining calm with extra effort led later in almost every case, to disrupting after effects.

This subject felt that the use of two balls hurried the 'limbering up process.' It did cut down the total time considerable. In approaching the problem this subject said, "Attention is set up as soon as I take up my stance. The swing or stroke is not cut up into so many discrete movements, it is a unified process." Later; "My failures are often the result of overtrying- -although there are a great many disturbing factors. Confidence is often lost after a string of failures, leading to further failures." Fourth practice; "When I try to make a too perfect shot I frequently miss, makes the reaction too obvious." Again, "The proper swing

is acquired at times without any noticeable effort. Can't always hold to the pattern or maintain proper tension. I miss a number at times due to hurrying myself." Later; "Am somewhat tired from stooping over--may have contributed to my failure to hold pattern."

On November 11, he said; "It takes extra effort to do well with people peeping in." Also, "The second ball bothers me at times, hurries my shot and diverts my attention." On the day that this subject made his best score he said, "After having shot a few, "Pattern is very stable today -fell right into it. It is all coming back to me now. I was consciously trying to make each shot smooth with an initial delay at the beginning of stroke. A choppy swing tends to sharpen the movement too much. One always knows the correct swing but can't do the right thing. Paying less attention to extraneous factors improves one's strokes." After vacation, subject with cold. "I find the pattern very uncertain and unstable. I have it one moment and then lose it." First time at longer distance; "It takes a little time to get the distance. Know pretty well what to do but it is hard to remain at the proper tension." His first performance at this distance proved to be an average one, although his final practices were better.

TABLE IV

4, B. S. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits: 1st ½	hits: 2nd ½	% 1st	% 2nd	% 3rd	% 4th	off	zone	zone	zone	zone	rack
Samples of subject's performances as recorded by Roff													
2. 2/22	30	36	24	8-10	6-10	16- 8	26-28	8-20					
14. 3/27	42	44	40	16-10	14-16	10-14	8-16	8- 4					
25. 4/24	64	62	66	4- 4	16- 8	6- 4	8-10	4- 8					
Present relearning record at distance of 9 feet													
1. 11/10	37	22	52	6- 2	14- 6	18-12	26-24	14- 4					
2. 11/12	56	50	62	6- 4	12- 8	14- 8	12- 8	16-10					
3. 11/15	58	44	72	8- 4	12- 6	16-12	10- 4	10- 2					
4. 11/17	51	46	54	6- 8	8- 8	88-14	6-14	20- 8					
5. 11/19	55	60	50	4- 4	8- 8	18-10	4-12	6-16					
6. 11/24	47	42	52	6- 6	12- 8	12- 6	14-12	14-16					
7. 12/ 2	47	42	52	10- 6	14- 8	10- 8	14-10	10-18					
8. 12/9	39	50	28	6-12	12-12	10-22	8-10	12-16					
9. 12/12	55	56	54	12-12	10- 4	2- 8	8-14	10- 8					
Averages	49	45	52	7- 6	11- 7	12-11	11-12	11-10					
Moved back to 13½ feet													
10. 12/18	19	20	18	8- 4	20-10	20-12	8-28	24-28					
11. 1/9	37	36	38	6-10	16- 6	14-14	16-18	8-18					
12. 1/16	42	42	42	18-14	12-16	12-14	8- 8	8- 6					
13. 1/19	51	48	54	6-14	16-16	12- 8	12- 4	6- 4					
14. 1/23	47	46	48	6- 8	18-16	24- 8	4-16	2- 4					
Averages	39	38	50	8-10	16-14	16-10	9-14	10-12					

— Original learning curve
 - - - Relearning curve
 — Original gross error
 - - - Relearning gross error

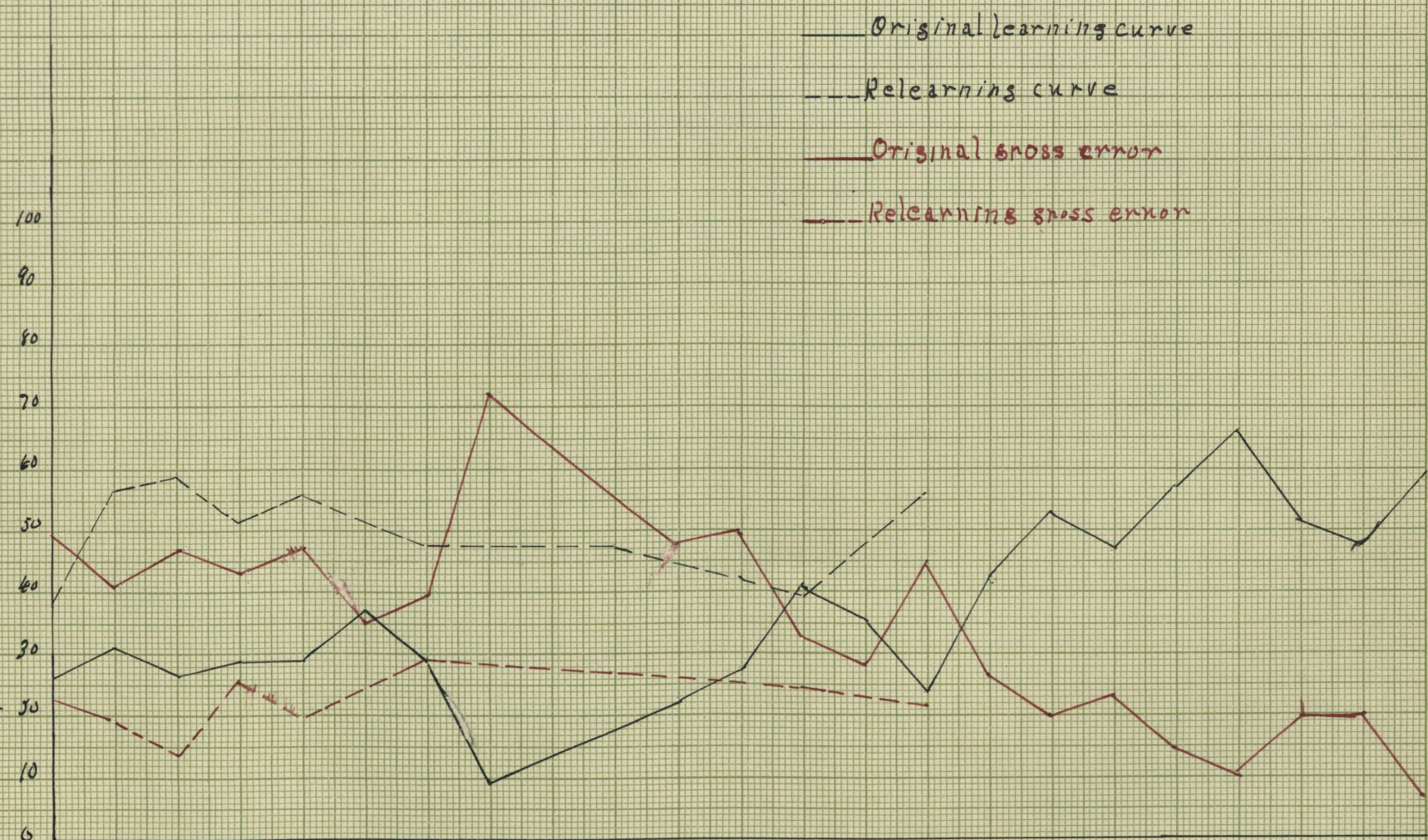
% of Correct Shots and Gross Errors

100
90
80
70
60
50
40
30
20
10
0

10 12 15 17 19 24 2 9 12
 November December

Dates of Practice Periods
 for relearning

#4 B.S.I



% of Correct Shots and Gross Errors

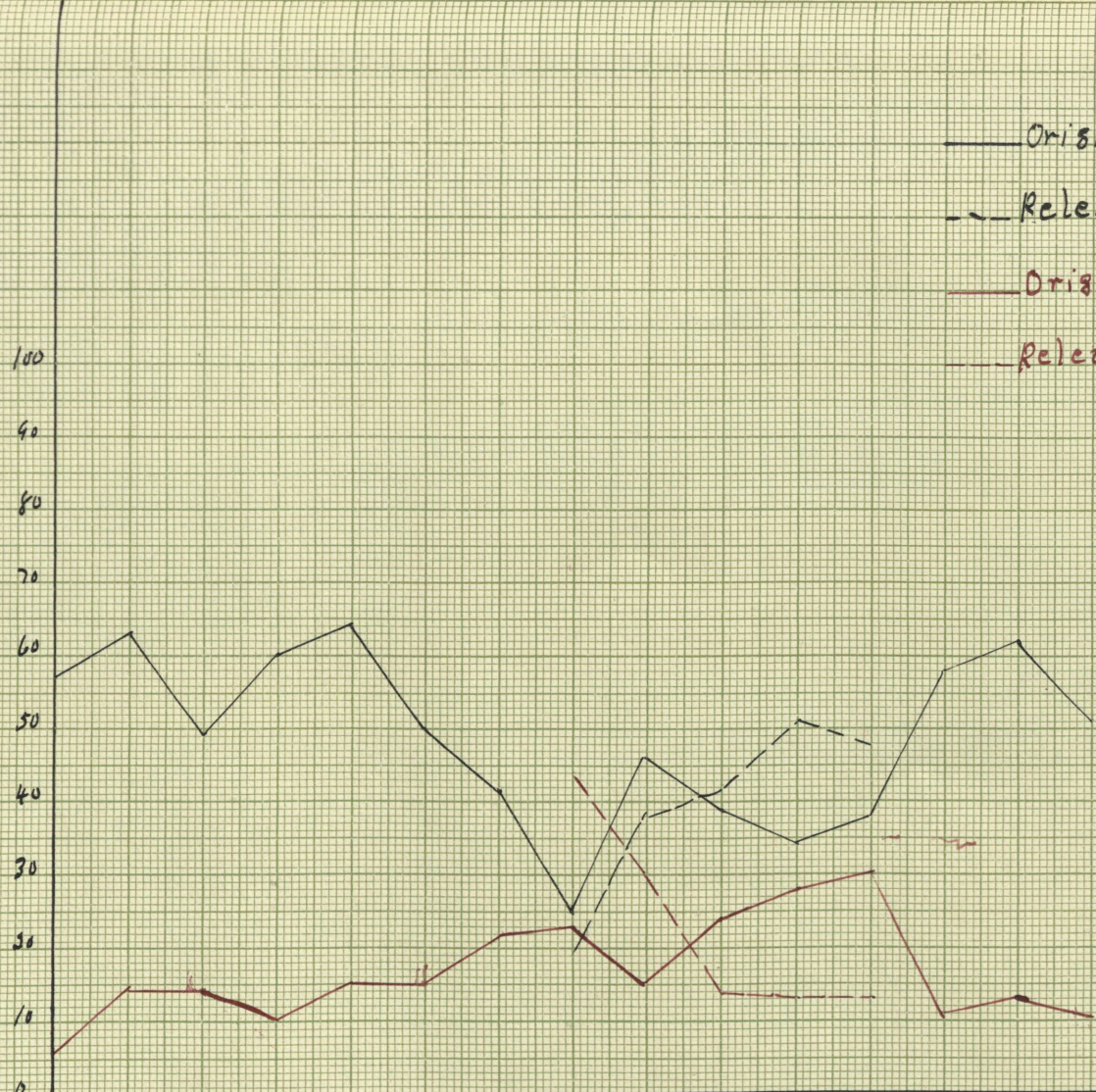
100
90
80
70
60
50
40
30
20
10
0

— Original learning curve
- - Relearning curve
— Original gross error
- - Relearning gross error

18 9 16 19 23
Dec. January

Dates of Practice Periods
for relearning

#4 B.S. II



DAILY RECORD SHEET

<u>##4, B. S.</u> subject	<u>11/17/30</u> date	<u>4</u> no. ferß.	<u># 51</u> hits*H
1.	26. H	51. H	76. H
2.	27. H	52. H	77. H
3.	28.	53.	78. H
4. H	29.	54. H	79. H
5. H	30.	55.	80.1
6. H	31. H	56.	81.
7.	32. H	57. H	82.
8. H	33.	58.1	83.
9.	34.	59. H	84.
10. H	35.	60.	85. H
11. H	36.	61.	86. H
12.	37.	62. H	87.
13. H	38. H	63.	88.
14. H	39. H	64. H	89.
15.	40.	65.	90.
16.	41.	66. H	91. H
17.	42	67. H	92. H
18. H	43. H	68.	93. H
19. H	44. H	69. H	94.
20.	45. H	70.	95. H
21.	46.	71. H	96. H
22.	47.6 H	72.H	97. H
23.	48.1	73.	98. H
24. H	49. H	74. H	99. H
25. H	50. H	75.	100.

#4, B.S. This subject had not played any golf since the close of the Roff experiment. He did not appear entirely at ease under the present conditions. Was always conscious of people passing in the corridor and anticipated their stopping to observe. He admitted having considerable difficulty at the outset in getting the right feel to bring about a correct stroke. The last half of his initial performance was a great improvement over the first. He said, "The pattern tends to become more stable, resulting in an increase of hits. The variable counter stresses must be resolved before coordination sets in." Second practice. A decided improvement over the first. Subject had been running, was somewhat sore and stiff. Also had a cold. Third practice. further increase. Feels almost confident of being able to call shots on a good day, when pattern is vivid. Said, "A successful, nicely arched shot gives a feeling of satisfaction." Admitted that with a series of hits the tension set up increases rapidly. Is of opinion that relaxation periods properly timed would lessen number of failures materially. November 17. Very erratic following a disturbance, had great difficulty in getting settled. This subject quite often tried different stances and grips- in endeavoring to bring about an improvement. Fifth practice. Subject said he didn't feel very confident. Shot a good score. After a weeks lapse. Subject did well the first half but fell off greatly the second. Had no explanation, however, disturbance in the hall seemed to create a little nervousness.

This subject, as will be noted from table IV, did not

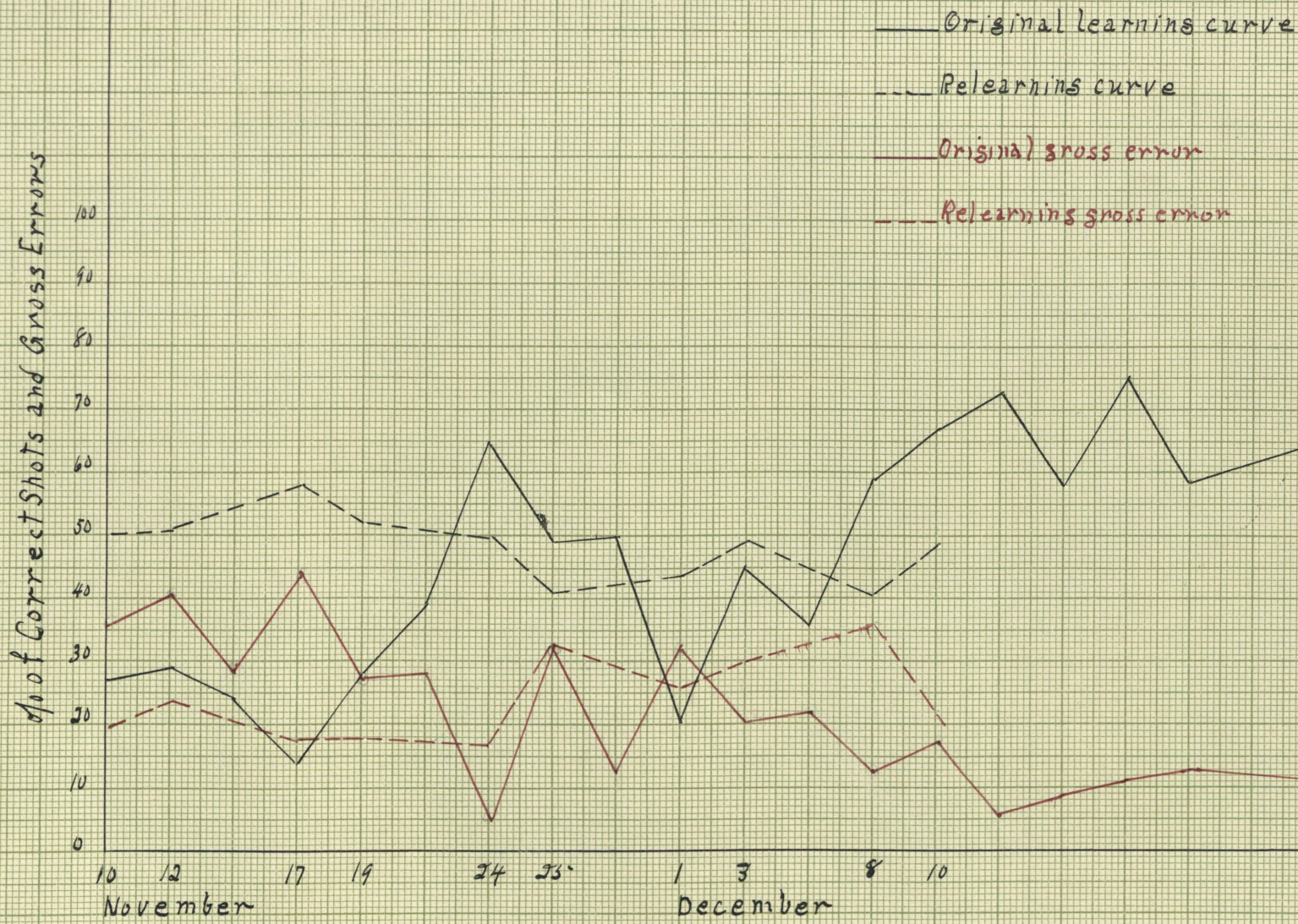
practice at very regular intervals. He did considerable track work, and as a result his muscles were undergoing constant changes, no doubt influencing his performance. He moved frequently between shots, kept informed of his progress at quarterly intervals, and always sought to improve. He felt the need of 'warming up' and also of being relaxed to perform at par. He varied in the rate at which he shot, placed the ball very carefully on the ~~same~~ spot on the mat each time and sought to make every shot good. It appeared to the experimenter that at times he made the performance too obvious by too conscious attention and over effort. At such times not the best performance would be turned in; this held for every subject.

First practice at longer distance. Started very badly, he said, "I have no feeling of the pattern at this distance." He experimented considerable. After vacation, lapse of a few weeks. Improved over his previous score. Becomes more easily tired at this distance. Experiences a feeling of relaxation after a hit. Length of intervals between practices seems of small significance after the subject is skilled. Final period- -subject had a stiff arm from injury. Shot more slowly and shot many short. The usual amount of energy seemed insufficient. Subject stated that he did not have a clear pattern, reached a good average mark however.

TABLE V

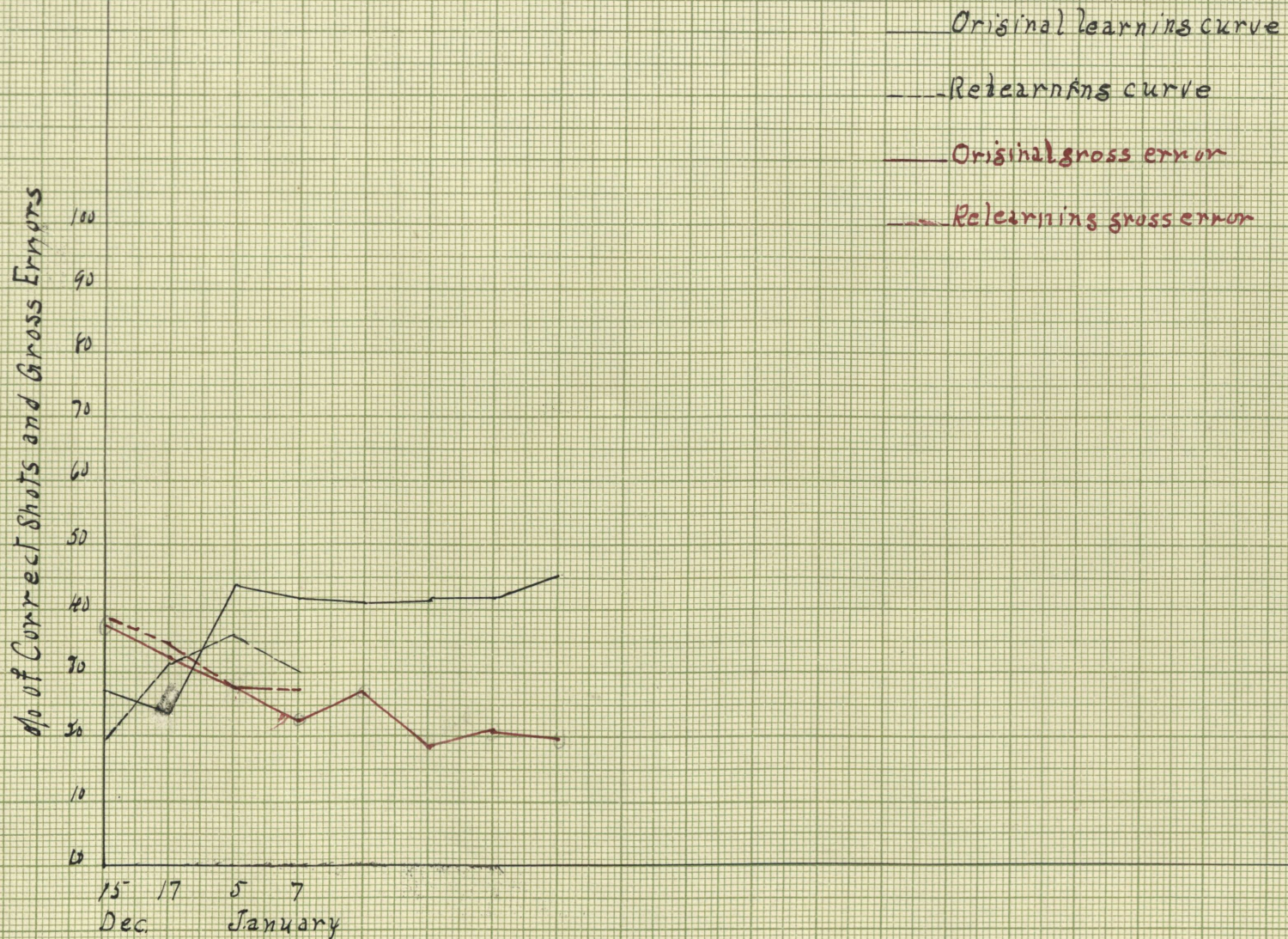
5, C. W. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and Date	total hits	hits: 1st $\frac{1}{2}$	hits: 2nd $\frac{1}{2}$	% 1st: zone	% 2nd: zone	% 3rd: zone	% 4th: zone	% off: rack
: Samples of subject's performances as recorded by Roff :								
: 2.	3/10	28	36	20	6-12	16-12	8-10	18-16 16-30:
: 13.	4/4	58	46	70	6-10	20- 6	20- 4	4- 4 4- 4:
: 19.	4/23	67	68	66	4- 4	12-18	6- 2	10- 8 - 4:
: Present relearning record at distance of 9 feet :								
: 1.	11/10	49	52	46	8- 8	10-12	14-12	6-22 8- 6:
: 2.	11/12	50	46	54	10- 8	12- 8	10-12	14-12 8- 6:
: 3.	11/17	57	46	68	4- 6	10- 8	16- 8	12- 6 8- 4:
: 4.	11/19	51	44	58	10- 8	12- 8	10-14	16-10 8- 2:
: 5.	11/24	49	46	52	12- 6	10- 6	14-22	8- 6 10- 8:
: 6.	11/25	40	42	38	8- 4	6-10	14-18	16-20 12-14:
: 7.	12/1	43	42	44	8- 4	10-16	14-14	12-12 14-10:
: 8.	12/3	48	38	58	10- 4	10-10	14- 6	14-16 14- 6:
: 9.	12/ 8	40	42	38	4- 6	6-10	10-16	20-10 18-20:
: 10.	12/10	48	44	52	6- 8	6-10	24- 8	8-12 12-10:
: Averages		47	44	50	8- 6	9- 9	14-13	12-12 11- 8:
: Moved back to 13 $\frac{1}{2}$ feet :								
: 12.	12/15	19	10	28	10-14	14-10	26-12	20-26 20-10:
: 13.	12/17	32	32	32	4- 8	10-12	20-12	14-22 20-10:
: 14.	1/5	36	32	40	4- 4	16-14	20-16	12-12 16-14:
: 15.	1/7	30	34	26	12-12	10-18	14- 8	16-24 14-12:
: Averages		29	27	31	7- 9	12-13	20-12	15-21 17-12



#5 C.W. I

Dates of Practice Periods
 for relearning



#5 C.W.I

Dates of Practice Periods
for relearning

DAILY RECORD SHEET

<u># 5, C. W.</u> subject	<u>11/12/30</u> date	<u>2</u> no. perf.	<u># 50</u> hits-H
1.	26. H	51.	76. H
2. H	27.	52. H	77.
3. H	28.	53. H	78. H
4. H	29.	54.	79.
5.	30. H	55.	80.
6.	31. H	56. H	81.
7.	32 H	57.	82. H
8. H	33.	58.	83.
9.	34.	59.	84.
10.	35.	60. H	85. H
11. H	36. H	61. H	86. H
12.	37. H	62. H	87. H
13.	38. H	63. H	88. H
14.	39. H	64.	89.
15. H	40. H	65. H	90. H
16.	41. H	66.	91. H
17.	42 H	67.	92. H
18.	43.	68. H	93. H
19.	44. H	69. H	94.
20. H	45.	70.	95. H
21.	46. H	71. H	96.
22.	47. H	72. H	97.
23. H	48.	73. H	98. H
24.	49.	74.	99.
25. H	50.	75.	100. H

#5, C.W. This subject had been one of Roff's best and most consistent performers previous to a change of conditions. For his first retest score he shot 49, eighteen below his best score made during the final week of the original experiment. He stated that the shooting seemed very natural, and that he had a distinct feel of how to hit the ball and with what force, although he couldn't always do it of course. This subject shot rather deliberately, and always spaced his strokes about equally. His only golf experience consisted of the practices while serving as subject. He took a conventional stance, gripped the club high, and swung from the shoulders with a stiff arm movement, which made his stroke comparatively long. His particular method of shooting, tenseness in the arms and shoulders, tired him rather quickly,

His third practice; scoring 57, proved to be his best. Sixth practice. After a rather erratic start he said, "I don't seem to be able to warm up to usual form, havent the feel. I get the right feel only with effort and then cant hold it. I feel alright otherwise, cant explain why I am not hitting." Proved to be one of two worst performances. At the beginning of his eighth practice he stated that he was not greatly motivated, but intended to try with effort to make a new high score. His score was three above his lowest. On a later date he estimated a score of 40, shot 48. December 8. "Feel fine- -havent any idea what I'll shoot." Late, "I cant get into the swing at all, and when I do have the correct pattern I cant hold it."

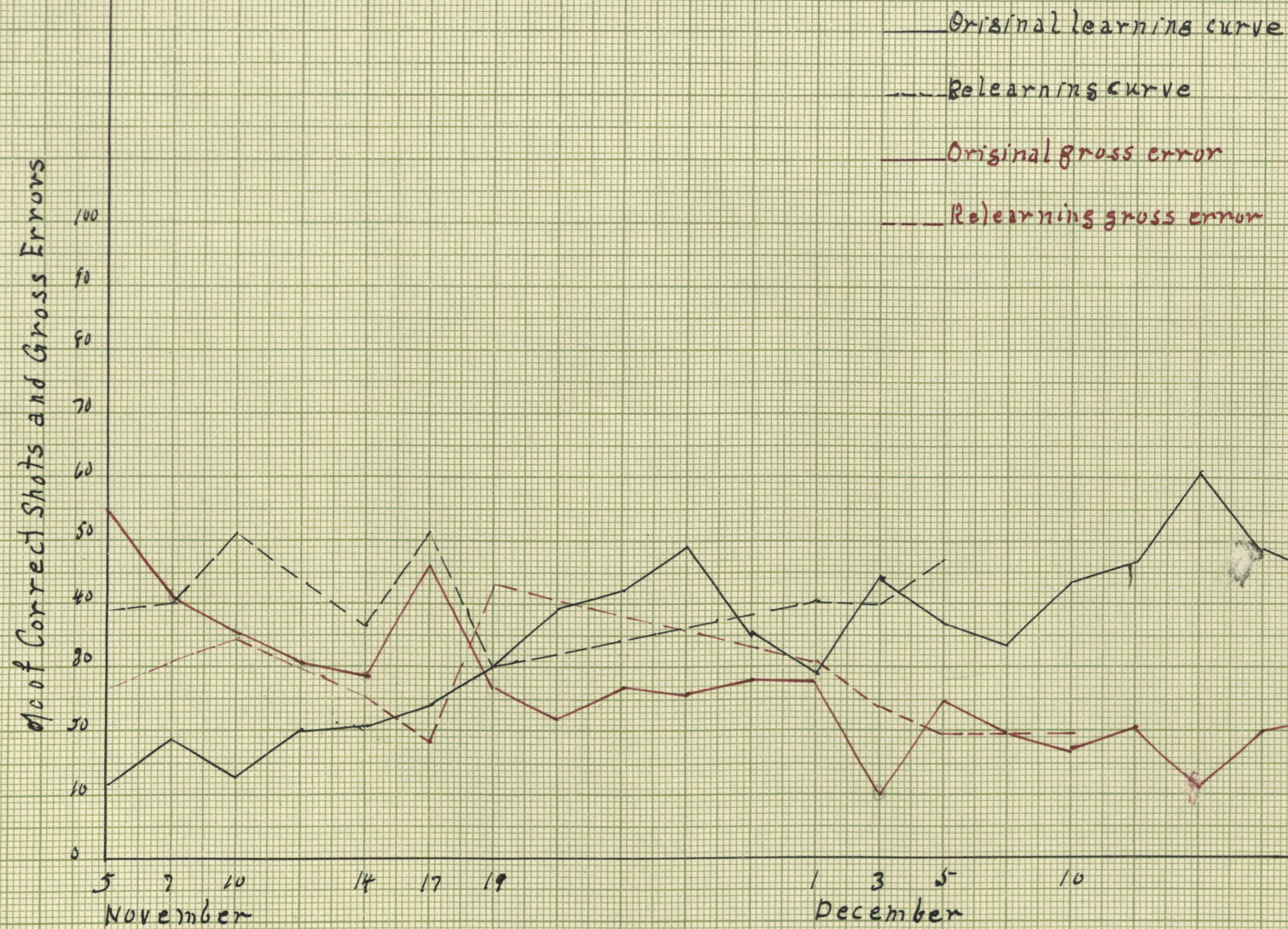
Upon being moved back to the farther distance this

subject experienced great difficulty in bringing about coordination. Said he had no pattern to speak of. Strain in back much more evident. Roff explained that this subject had not been able to adapt himself readily to a change of conditions. Second time back, he got the distance very quickly and almost doubled his mark. After vacation, two weeks later. His first performance showed improvement over his pre-vacation form. Taken as a whole this subject showed but very slight improvement over his first relearning performance. He bettered his initial score a few times but after the fifth practice his accuracy fell off considerably, as table V shows clearly. The subject himself had no answer for his inability to come up to the proficiency he had attained under Roff. The new conditions may have been a contributing factor. It also appeared to the experimenter that after the fifth practice in the case of a few of this group they became less interested, became tired of doing the same thing they had done for a long period the spring before. The goal had been to find out how well they could do after a lapse. Once that was known there was less to strive for, since they already knew just about what they could do with continued practice.

TABLE VI

6, S. G. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

: No. and : date	: total: : hits	: hits: : 1st $\frac{1}{2}$: hits: : 2nd $\frac{1}{2}$: % 1st: : zone	: % 2nd: : zone	: % 3rd: : zone	: % 4th: : zone	: % off: : rack
: Samples of subject's performances as recorded by Roff :								
: 2. 2/26	18	12	24	2-12	10-16	28-18	26-10	22-20:
:14/ 3/26	36	28	44	6-10	16-24	22- 6	20-10	8-10:
:25. 4/20	52	48	56	2-12	14-18	14- 4	16- 4	6- 6:
: Present relearning record at distance of 9 feet :								
: 1. 11/5	38	36	40	8-10	12-10	18-14	12-12,12-14:	
: 2. 11/7	39	34	44	6- 8	8-10	14-16	20-16	18- 8:
: 3. 11/10	50	44	56	8- 8	8-12	16-12	12-22	10- :
: 4/ 11/14	36	36	36	6- 8	14- 8	18-22	16-16	10-10:
: 5. 11/17	51	44	58	8- 4	12-12	18-14	10-10	8- 6:
: 6. 11/19	29	22	36	8-	12- 6	18-14	22-26	18-18:
: 7. 12/1	40	36	44	6-12	4- 8	12-18	24-10	18- 8:
: 8. 12/3	39	34	44	6- 8	16- 8	22-18	14-14	6- 8:
: 9. 12/5	46	44	48	4- 8	12- 8	20-18	14-14	6- 4:
:10. 12/10	51	44	58	4- 8	14-10	16- 6	12-16	10- 2:
: Averages	41	37	46	6- 7	11- 9	17-15	15-12	12- 8:
: Moved back to 13 $\frac{1}{2}$ feet :								
:11. 12/15	18	20	16	4- 4	6-12	12- 6	30-34	28-30:
:12. 1/5	27	18	36	10-16	20-12,26-12,	6-12	16-12:	
:13. 1/7	33	28	38	12-	26- 6	6-22	14-24	14-10:
:14. 1/9	34	36	32	16- 8	16-20	30-18	-12	2-10:
: Averages	28	25	30	10- 5	16-14	18-14	12-20	14-15



#6 S.G.I

Dates of Practice Periods
For relearnings



#6 S.G. II

Dates of Practice Periods
for relearning

DAILY RECORD SHEET

<u># 6, S. G.</u> subject	<u>11/10/30</u> date	<u>3</u> no. perf.	<u># 50</u> hits-H
1.	26.	51. H	76. H
2.	27. H	52.	77.
3. H	28. H	53. H	78. H
4. H	29.	54. H	79. H
5.	30. H	55.	80. H
6.	31.	56.	81. H
7. H	32.	57.	82. H
8.	33.	58.	83.
9. H	34. H	59.	84. H
10. H	35.	60.	85.
11. H	36.	61.	86.
12.	37. H	62. H	87. H
13. H	38.	63. H	88.
14. H	39.	64.	89. H
15.	40.	65. H	90.
16. H	41 H	66. H	91.
17.	42.	67. H	92.
18. H	43. H	68. H	93.
19.	44.	69. H	94. H
20.	45. H	70. H	95. H
21.	46.	71. H	96.
22. H	47.	72.	97. H
23.	48.	73. H	98. H
24. H	49. H	74. H	99.
25. H	50.	75. H	100. H

#6, S.G., had not practiced since the time she had served as subject for Roff. She gripped the club high which made her stance almost upright. Her swing although not long was free and regular. Ordinarily she appeared quite calm, muscles of arms not as tense as in the case of several others. She was however, easily disturbed by commotion in the hallway and by people parting the curtain and peeping in to observe the performance. During her first practice she said, "My swing seems too long. Its rather easy after one gets started." Third practice, score but 2 points short of her best score made during the final week of practice six months earlier. On two later occasions she approached within one point of this mark. Fifth practice, "Wish these people would go on, they bother me." Again later, "I become more tense with a long string of hits. Had a feeling today that the distance was shifting. Overcame it by concentrating on the ball." Shot 51, highest score. Sixth practice. "Cant seem to settle down. Dont feel any particular tenseness. Cant account for not being able to hit it. I try hard and know what to do." Her worst performance, score below her first.

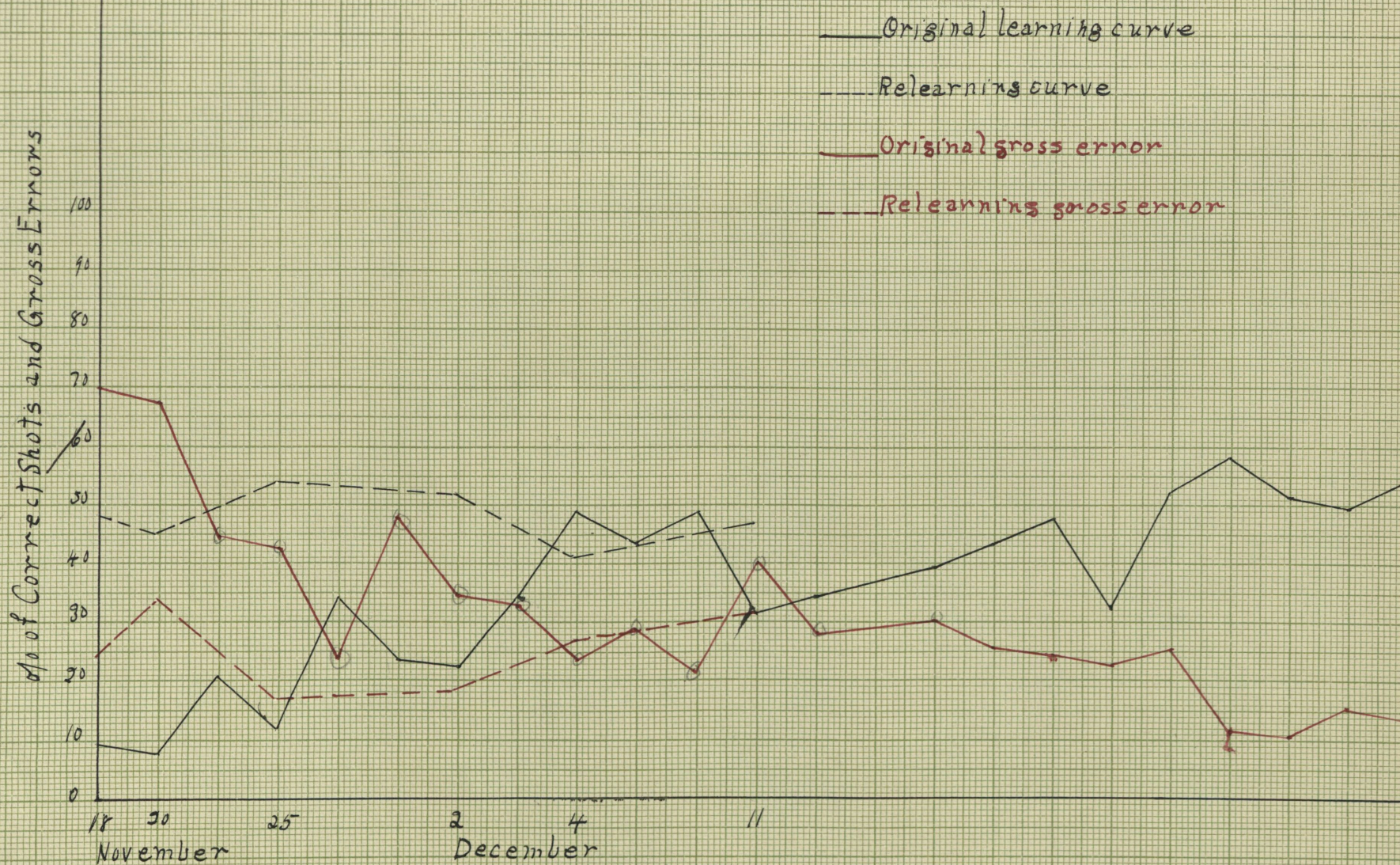
After vacation. "Cant get the feel." Comment after forced delay, "I hate to stop when I'm going good for fear of losing my swing- -find it hard to recover at times." On another day, "Concentrating on the ball enabled me to control my shots. Realized I had been too relaxed in the beginning. Had forgotten how to loft the ball." She found hitting the hole at the farther distance much harder. Following a three week lapse she returned to it again and improved her first score by one-half. Her fourth and final practice

showed a great improvement in general accuracy which her score does not reveal.

TABLE VII

7, E. J. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits: 1st $\frac{1}{2}$	hits: 2nd $\frac{1}{2}$	% 1st zone	% 2nd zone	% 3rd zone	% 4th zone	% off rack
Samples of subject's performances as recorded by Roff :								
3. 2/28	20	6	34	6-10	10- 6	20-20	40-18	18-12:
15. 3/28	43	32	54	10-12	16- 8	14- 8	16-10	8- 6:
24. 4/25	54	44	64	10- 8	12-10	18- 8	8- 6	4- 6:
Present relearning record at distance of 9 feet :								
1. 11/18	47	40	54	4- 8	10- 8	16-14	16-10	14- 6:
2. 11/20	44	34	54	4- 4	12-10	16-10	8-24	26- 8:
3. 11/25	53	44	62	6- 2	10- 6	20-18	18-10	2- 2:
4. 12/2	51	56	46	2- 6	12-18	8-18	14- 8	8- 2:
5. 12/4	40	38	42	6- 4	8-10	22-18	12-20	14- 6:
6. 12/11	46	46	46	8- 4	6-10	8- 6	18-24	14- 8:
Averages	49	43	50	5- 4	9-10	15-14	14-16	13- 5:
Moved back to 13 $\frac{1}{2}$ feet :								
7. 1/6	19	20	18	8- 6	14-14	18-24	16-24	22-14:
8. 1/9	23	18	28	8- 4	22-12	18-22	18-14	16-20:
Averages	21	19	23	8- 5	18-13	18-23	17-19	19-17



#7EJ

Dates of Practice Periods
for relearning

DAILY RECORD SHEET

<u># 7, E. J.</u> subject	<u>12/2/30</u> date	<u>4</u> no. perf.	<u># 51</u> hits-H
1. H	26. H	51.	76.
2.	27.	52.	77. H
3. H	28.	53.	78. H
4. H	29.	54.	79.
55. H	30. H	55.	80.
6.	31. H	56. H	81.
7.	32. H	57. H	82.
8.	33. H	58. H	83. H
9.	34.	59.	84.
10.	35.	60.	85.
11. H	36.	61.	86.
12.	37.	62.	87.
13.	38. H	63.	88.
14. H	39.	64. H	89. H
15. H	40. H	65. H	90. H
16.	41. H	66.	91. H
17. H	42. H	67. H	92. H
18. H.	43. H	68.	93. H
19. H	44.	69. H	94. H
20. H	45. H	70.	95. H
21.	46. H	71. H	96. H
22.	47. H	72.	97.
23. H	48. H	73.	98. H
24.	49.	74. H	99.
25. H	50. H	75. H	100. H

#7, E.J. This subject had not golfed any during the summer. She was particularly disturbed by the presence of spectators and seemed to be always more or less apprehensive lest some one would stop and observe the performance, which of course did happen on several occasions. She admitted a number of times that she did not like to shoot while others watched. Roff stated in his experiment that she was his best feminine subject, and she did well when not disturbed, during the present relearning period. Her practices are few and irregular. Her initial retest score was only seven below the best score obtained during the final week six months previous. Her relearning average is 49, and very likely would have been better had the conditions been more satisfactory. She had acquired a good stance and freedom of movement, shot very rapidly, and didn't stop to analyze her technique or mistakes.

The first time up she stated that she seemed to know almost immediately how to hit the ball and with what force. This subject, as intimated, often hurried her shots too much, hoping to finish before an audience would appear. Differing from some of the others in one respect she scarcely ever looked at the target except as she followed through with the stroke. Her adjustments were, admittedly, on the basis of a certain feel or pattern, which was easily recognized when present. At the opening of her fifth practice she said, "I feel unusually tired- -also sleepy." It proved to be her worst day. Upon being shifted back to the farther distance after the vacation, a three week lapse, she failed to get any good

coordination into her stroke during her two practices.

TABLE VIII

8, R. B. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits:1st $\frac{1}{2}$	hits:2nd $\frac{1}{2}$	hits:% 1st	hits:% 2nd	zone	zone	zone	zone	off: rack
1. 2/10	22	14	30	12-10	18-14	8-18	22-16	26-12		
2. 2/11	30	34	26	2- 8	14- 8	22-12	6-28	24-18		
3. 2/13	31	26	36	14- 8	14-12	10-14	18-20	18-10		
4. 2/16	32	28	36	10-12	8- 6	16-16	22-12	16-16		
5. 2/18	42	36	48	14- 8	14-12	8- 6	16-16	12-10		
6. 2/20	41	36	46	14-22	10- 8	16-10	18- 4	8-10		
7. 2/23	42	46	38	12-14	18-16	14-20	2- 8	8- 4		
8. 2/25	63	56	70	10- 8	24-12	6- 6	2- 2	- 2		
9. 2/27	53	46	60	8-16	26- 4	10- 6	6-12	4- 2		
10. 3/2	53	52	54	12-14	16-12	14-12	2- 4	4- 4		
11. 3/4	45	42	48	10- 8	16-14	16-12	8-10	8- 6		
12. 3/6	44	46	42	12-12	18-10	8-12	6-16	10- 8		
13. 3/9	36	34	38	12-12	14- 8	18-26	6- 8	10- 6		
14. 3/11	49	52	46	6-12	10-12	16-16	8-10	8- 4		
15. 3/13	52	42	62	16- 6	14-12	14-12	10- 6	4- :		
16. 3/16	50	48	52	12-10	8-12	14-12	12- 8	6- 6		
17. 3/18	47	42	52	14- 6	12- 4	14-22	14- 8	6- 8		
18. 3/20	41	40	42	14-12	18-16	10-20	16-10	2- :		
19. 3/23	64	60	68	8- 8	8- 6	12- 8	4- 6	8- 4		
20. 3/25	55	62	48	8-14	8-14	16-16	4- 6	2- 2		
21. 3/27	42	50	34	6-12	6-14	20-12	16-16	4-12		
Averages	44	42	46	11-11	14-11	13-13	10-10	8- 7		
Moved forward to 9 feet										
22. 3/30	71	62	80	10- 6	6- 4	14- 4	8- 6	- :		
23. 4/1	68	66	70	12-10	6-12	14- 8	2- :	2- :		
24. 4/3	53	48	58	4- 6	10-12	24- 8	8-14	6- 2		
25. 4/6	60	60	60	6- 6	8- 6	16-12	8-10	2- 6		
26. 4/8	67	66	78	6- 6	18- 6	16-10	2- :	2- :		
27. 4/10	68	60	76	12- 4	12-12	10- 8	2- :	4- :		
Averages	64	60	69	8- 8	10- 8	15- 8	5- 5	2- 1		
Moved back to original distance 13 $\frac{1}{2}$ feet										
28. 4/13	42	38	46	6- 8	14-18	26-22	14- 2	2- 4		
29. 4/15	31	28	34	8-10	14-12	20-28	18-12	10- 4		
30. 4/17	51	56	46	4- 7	6-16	16-24	10- 8	6- 2		
Averages	41	40	42	6- 7	12-14	20-24	14- 8	6- 3		

% of Correct Shots and Gross Errors

— Daily Performance—correct shots
— Daily Performance—gross errors

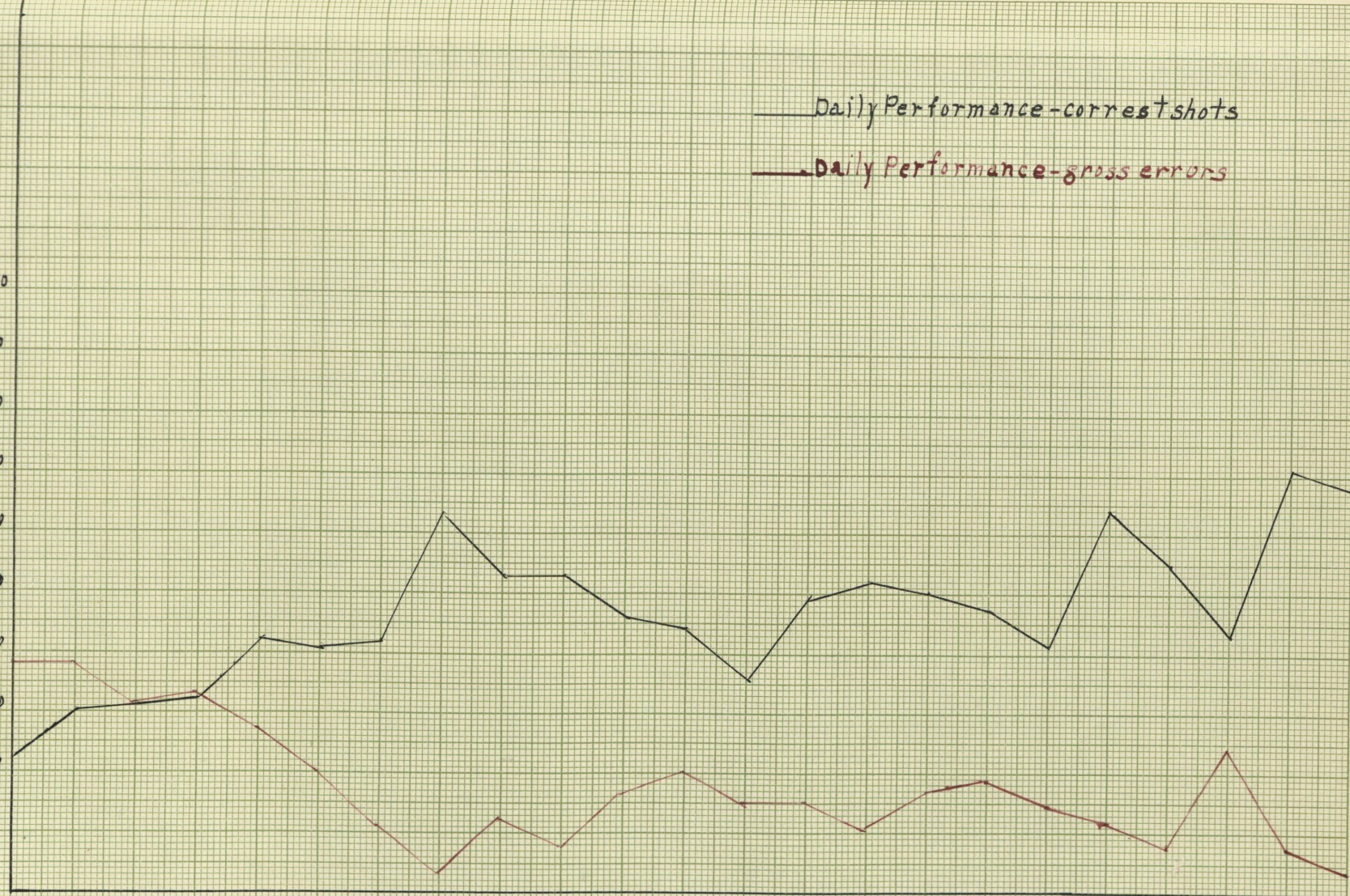
100
90
80
70
60
50
40
30
20
10
0

10 11 13 16 18 20 23 25 27 2 4 6 9 11 13 16 18 20 23 25 27 30 1
February March

Dates of Practice Periods

#8 R.B.

KEUFFEL & ESSER CO., N. Y. NO. 358-14
Millimeters, 10th lines heavy.



% of Correct Shots and Gross Errors

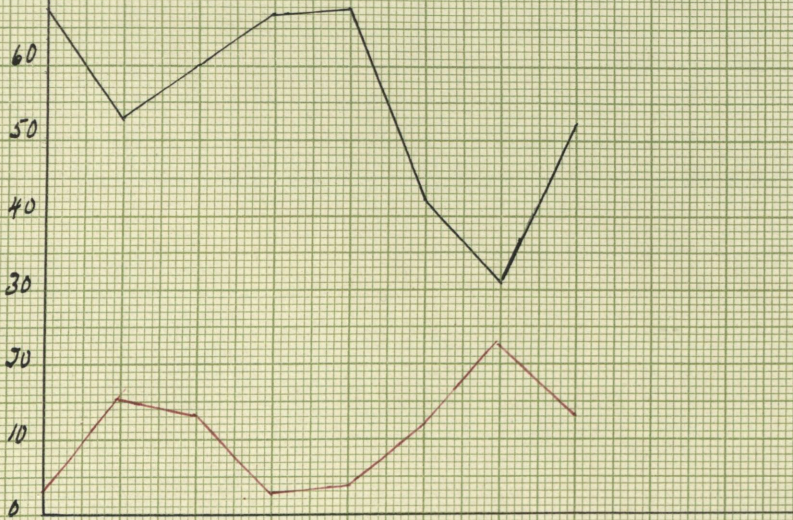
100
90
80
70
60
50
40
30
20
10
0

1 3 6 8 10 13 15 17
April

Dates of Practice Periods

#8 R.B II

— Daily Performance - correct shots
— Daily Performance - gross errors



DAILY RECORD SHEET

<u># 8, R. B.</u> subject	<u>3/16/31</u> date	<u>16</u> no. perf.	<u># 50</u> hits-H
1. H	26. H	51. long 5"	76. H
2. right $\frac{1}{2}$ "	27. H	52. long 3"	77. H
3. H	28. short $\frac{1}{2}$ "	53. H	78. H
4. H	29. short 20"	54. right 1"	79. short 11"
5. short of rack	30. H	55. short 1"	80. H
6. H	31. long 3"	56. long 1"	81. long 9"
7. H	32. short 2"	57. short 18"	82. H
8. left 2"	33. H	58. H	83. H
9. long 4"	34. H	59. long 3"	84. short 7"
10. long 6"	35. H	60. short 15"	85. H
11. H	36. long 5"	61. right 1"	86. long 6"
12. short 16"	37. short 15"	62. long 5"	87. H
13. short of rack	38. H	63. H	88. short 4"
14. long 15"	39. short 1"	64. H	89. short 1"
15. short 7"	40. H	65. short of rack	90. H
16. long 20"	41. H	66. long $\frac{1}{2}$ "	91. H
17. short $\frac{1}{2}$ "	42. long $\frac{1}{2}$ "	67. H	92. H
18. long 2"	43. H	68. H	93. H
19. long 2"	44. left 5"	69. H	94. short $\frac{1}{2}$ "
20. H	45. H	70. H	95. H
21. H	46. H	71. short 6"	96. H
22. right 8"	47. long 7"	72. short 4"	97. right 2"
23. H	48. H	73. H	98. H
24. long 2"	49. H	74. H	99. H
25. short 18"	50. H	75. off rack	100. off rack

#8, R.B., the first of the new or second group had played some open field golf and had also practiced at this particular problem a few times the spring before. Not as a subject of course. He was anxious to get started and remained interested throughout. He was started at the $13\frac{1}{2}$ feet distance and practiced regularly three times a week, on Monday, Wednesday, and Friday, taking 100 trials per period. A knowledge of golf technique enabled him to recognize his faults and led to the development of a free and rhythmic stroke. In the main he took either one of two positions: one, a rather upright stance, legs apart and not much bend at the waist, gripping the club high up, resulting in a medium length swing, in the other position he placed his head and shoulders well over the ball, feet close together, club gripped low, leading to a sharp quick stroke. The latter stance was the most often used, although quite a bit of experimentation with stances and methods of holding club was noted. The first time up he stated that he was not interested in a high score as such, rather he aimed to perfect his stance and method of handling club. He found that the club took a natural position when held straight. Also that a right and wrong feel was quickly evident. It will at once be noted that this subject approaches an analytical type. He commented freely upon his reactions.

Remarks during first practice: "I am trying to get orientated, I have a rather helpless feeling. Satisfied feeling with success. Failure due to lack of tension and care. I am glad there are no spectators present, am self-

conscious." Second practice. "I am beginning to see what to do but can't always do it. I'm trying to recover pattern that brought me success last time." Third practice. "Subject observed a lessening in the number of variations in stance, shifting of grip etc., due to more coordination. Believed the spotting of ball important. Second week. Was bothered by injured wrist but seemed to be in a competitive mood. Found he had forgotten to follow through for a while. He said, "Lost pattern when I stopped to speak." Had doubled his initial score at the end of second week. Start of third week: "I can't control my muscles. Head and hands sort of feel detached--no sense of coordination. Can't make a long series of hits." Later in week, February 25. Subject felt fine and was possessed of confidence. Desired to reach new high peak.

It should be mentioned here that on the day preceding this subject had taken 400 shots, giving particular attention to stance, grip, and follow-through. He had discovered that by maintaining a constant position, standing farther back from mat, gripping club higher, and getting more arm and body into the stroke led to more rhythmical movement and helped greatly to stabilize his shooting. Fewer fine muscular adjustments were required. So on this day he took the upright stance with lengthened grip on club that he had found satisfactory. Makes a new high score, 63, twenty-one above that of previous regular practice. Some psychological factors undoubtedly helped to account for this particular performance because he dropped again later.

First, the subject felt greatly motivated, also intensely interested, wondering about the probable outcome. He felt that he needed to show improvement. He scarcely moved from his position throughout the performance, concentrating on his every stroke. This was evident because he showed annoyance at petty disturbances, such as rebounding of ball. It is true that this proved more or less disturbing to all the subjects throughout, more at one time than another. However, it appeared evident to the experimenter that the high score made was not so much the result of practice as it was due to the quality of the performance. That is, concentration on the task, care and precision in execution, pausing at the sign of strain, and the deep desire to make a high mark following a long extra practice. Next practice. Subject admitted a poor mental set at outset, not confident. "No feeling of pleasure in today's shooting." He felt that the pattern was differentiating more and more, looks at the hole less and shoots more by feeling alone--kinaesthesia.

March 2. "Feeling was beautiful for a while, everything was perfect. Seemed as if I could hit every time with ease. A bouncing ball disturbed me and I've lost the pattern."

March 9. Shot a low score, 36. Felt fine at the start. Scored first four and became erratic. "I feel lost, haven't the pattern. Change of stance appears to have broken up my form. Am trying my hardest, don't know what is wrong."

March 13, one stance and shifted into another. Predicted a bad score. "Can feel the pattern leave while I wait for return of the ball." Shot a big average. March 18. "Whole situation doesn't look right. Same things don't work every day. I'm disgusted, can't hit anything and I don't care."

Noticeable relaxation followed and the performance improved greatly. Subject had been overtrying and got too tense. Coordination is not possible at too high tension or pressure. Nineteenth practice, highest score at this distance. Subject was confident and admitted a definite set or feel. Shot rapidly. "Shooting fast lessens irradiation, give one less time to analyze and overtry."

Comments upon being brought forward to nine foot distance. Situation appeared about the same, subject was tense at the start, used choked grip and a quick snap and found method successful. Started slowly scoring first three. Admitted feeling cramped although it seemed easier at short distance. "I have feeling of flexibility and it seems that the adjustments need be less concise." Scored 7 above his former high mark at the farther distance. Second practice at nearer distance. Mat at incorrect angle disturbed subject. Was depressed, commented on the dreariness of the day, thought it influenced his performance. Last practice at short distance. "Feel fine. Shooting from nearer distance is easier. Too much effort does not contribute to success. Some days I can hit and on others I cant."

Shifted back to original, farther distance. "Hole seems far away, I cant reach it. Distance bothers me most- -it takes longer to make adjustments. Target harder to locate." April 15, bad day out, heavy atmosphere. Subject said he was in a low state of consciousness, couldnt get into feel of correct shooting. Direction and distance both bad. Shot low score. Last practice. Subject felt very good. Tries first one stance, then another. "I have a very vivid

pattern today; seems like I can check irradiation at times by shifting from one stance to another. On other days it doesn't help any, nothing helps."

TABLE IX

9, M. M. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits: 1st $\frac{1}{2}$	hits: 2nd $\frac{1}{2}$	% 1st: zone	% 2nd: zone	% 3rd: zone	% 4th: zone	% off: rack
1. 2/11	30	26	34	10-14	8- 8	22-10	16-16	18-18
2. 2/13	36	30	42	8-12	12- 8	16- 8	18-14	18-12
3. 2/16	42	38	46	8-12	10-06	16-12	18-12	10-12
4. 2/18	40	50	30	12-16	18-12	10-20	-16	10- 6
5. 2/23	44	44	44	8-10	20- 8	12-12	8-12	8- 4
6. 2/27	51	62	40	16-	8- 6	8-16	2-24	-16:
7. 3/9	36	48	24	4-20	8- 4	20-16	16-20	4-16:
8. 3/12	44	48	40	20-14	8-12	8-20	8-16	8- 8:
9. 3/18	54	48	60	12- 8	16-12	16-12	4- 4	4- 4:
10. 3/20	40	32	48	4- 8	12-	28-24	14- 4	12-16:
11. 3/30	34	20	48	2- 4	12-12	24-16	16-20	24- :
12. 4/1	40	44	36	8-	8- 4	20-32	12-20	8- 8:
Averages	41	41	41	9-10	11-7	11-16	10-14	10-10:
Moved forward to 9 feet								
13. 4/8	55	50	60	8-10	10-10	12-14	14- 6	6- :
14. 4/10	48	46	50	8- 4	8- 8	20-26	12- 6	6- 6:
15. 4/14	48	48	48	4- 8	16-20	16-12	8-12	8- :
16. 4/16	42	56	28	2- 8	10-16	16-32	8-12	8- 2:
Averages	48	51	46	5- 7	11-13	16-21	10- 9	7- 2:
Moved back to original distance 13 $\frac{1}{2}$ feet								
17. 4/21	28	20	36	8- 4	8-20	28-16	24-24	12- :
18. 4/24	42	28	56	8- 8	16-16	24-16	12- 4	12- :
Averages	35	24	46	8- 6	12-18	26-16	18-14	12-

of Correct Shots and Gross Errors

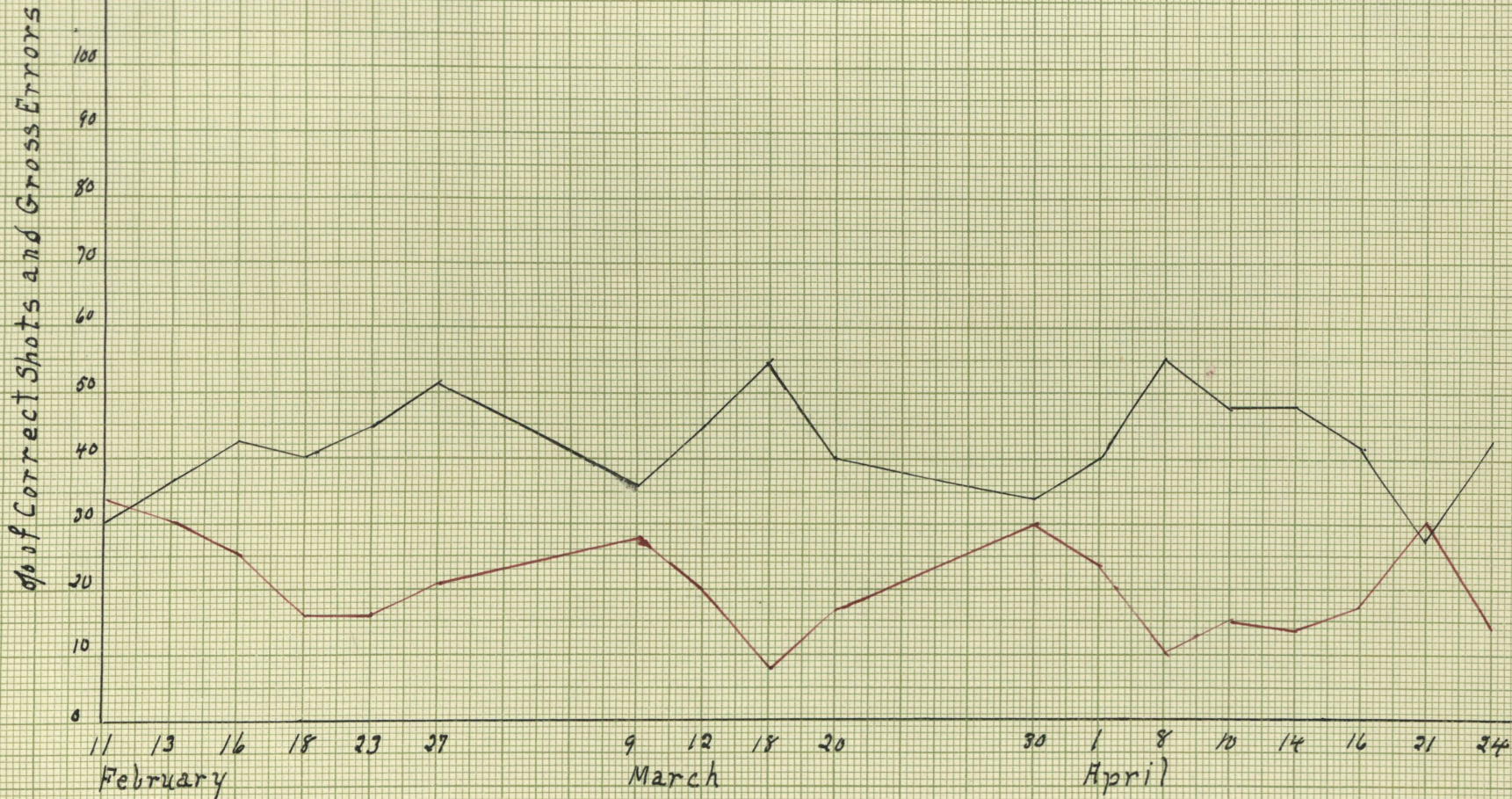
— Daily Performance-correct shots
— Daily Performance-gross errors

100
90
80
70
60
50
40
30
20
10
0

11 13 16 18 23 27 9 12 18 20 30 1 8 10 14 16 21 24
February March April

Dates of Practice Periods

#9 M.M.



DAILY RECORD SHEET

<u># 9, M. M.</u> subject	<u>4/10/37</u> date	<u>14</u> no. perf.	<u># 48</u> hits-H
1.	26. H	51. H	76. H
2.	27.	52. H	77.
3.	28.	53. H	78.
41	29. H	54.	79.
5. H	30. H	55.	80. H
6. H	31.	56.	81.
7.	32.	57. H	82.
8.	33. H	58.	83.
9.	34.	59.	84. H
10.	35.	60. H	85. H
11.	36.	61. H	86. H
12. H	37. H	62.	87. H
13. H	38. H	63. H	88.
14. H	39.	64. H	89. H
15. H	40. H	65. H	90. H
16.	41.	66. H	91. H
17. H	42. H	67.	92.
18.	43.	68.	93. H
19.	44.	69.	94. H
20.	45.	70. H	95.
21. H	46.	71.	96.
22.	47. H	72.	97. H
23. H	48. H	73.	98. H
24.	49. H	74.	99.
25.	50. H	75. H	100.

#9, M.M., had practically never played any golf. He scarcely varied from the stance with which he started, an upright position with the club gripped long. During his early performances he used just the one ball, or if two, he waited until the second ball returned to the mat. Attempting to shoot while the ball was coming down the run-way was almost impossible. Toward the close of the experiment he got to using the two balls, wasn't disturbed any more, and stated that he thought he could do better shooting more rapidly. No consistent gain is evident although his general accuracy was much better. This subject was also started at 13 $\frac{1}{2}$ feet and it should be noted that he practiced only twice a week and on irregular days, with two lapses of a week each. Most of the time he took but 50 trials during a performance.

First practice, subject wasn't feeling very well. Said he knew just about what to do but couldn't maintain the correct form. Tried to bring more wrist snap into his stroke during the second period. Shot very deliberately with considerable 'initial delay'. Trials were evenly spaced.

Third practice; subject felt fine. He had the idea that the mat was nearer the wall. Stated that he had a much more vivid feeling of a correct stroke. Maintained that keeping stationary position made the pattern more stable. Cramps fingers by gripping club too hard. "Pattern seems to have vanished, cant hit- -see spots before my eyes." Stated that he found it necessary to keep clearly in mind the total situation, concentrating on one thing and ignoring another leads to failure.

Fourth practice. Subject felt fine and was more con-

fident. Did well the first half, calling many of his shots. "Hole is getting bigger and bigger, more like a yawning cavity every day." Fell off badly second half, overconfident. Admitted he had lost the feel. March 18. Highest score at this distance. Measured every stroke carefully. Moved from position only once. "Hits came relatively easy today, no strain or particular effort." Practice following a week lapse. Subject had been ill. "Cant control my muscles. Try as hard as I can and the balls dont go in. Felt an unusual strain in his back before he finished. Was of opinion that a long lapse calls for a longer period of 'warming up'. Shot a low score.

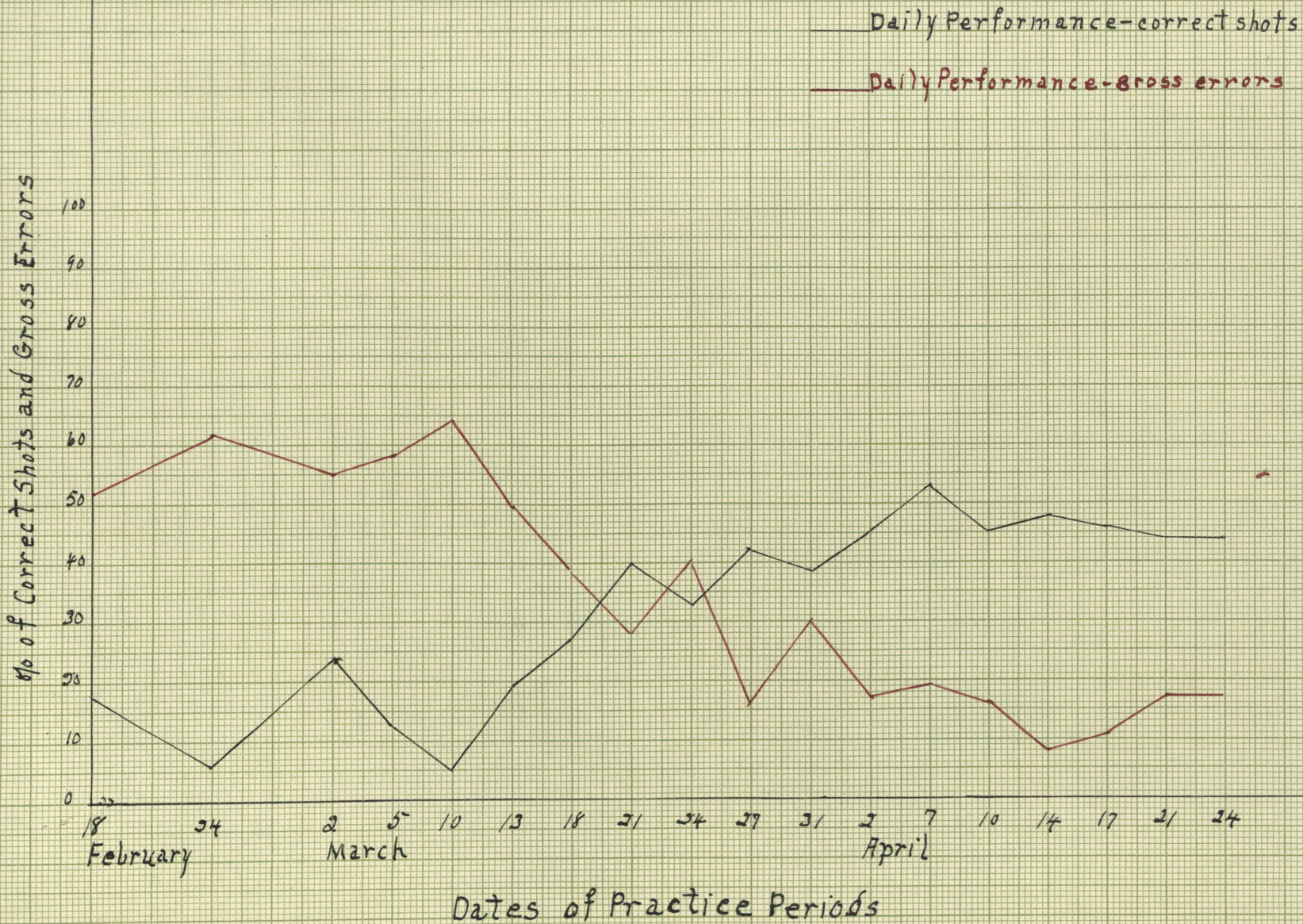
Moved forward, to within 9 feet of hole. This subject didn't think that shooting from the nearer distance was any easier. Attributed his better success to change in shooting, using two balls, cutting down intermission between shots. However when he hurried too much he lost in accuracy.

Moved back to original. Subject was considerably upset the first time back again. Overshot most of the time, couldn't get the correct pattern- -muscles out of control. Using two balls didn't seem to help any. Final practice, subject felt fine. Did poorly the ~~first~~ first half. "I have no feel at all of correct form. I felt more relaxed the second half- -had a clear pattern and seemed to be able to hit the hole with perfect ease."

TABLE X

10, N. R. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits:1st $\frac{1}{2}$	hits:2nd $\frac{1}{2}$	hits:%1st zone	hits:%2nd zone	hits:%3rd zone	hits:%4th zone	hits:%off rack
1. 2/18	18	20	16	4-8	4-6	12-20	28-28	32-16:
2. 2/24	6	4	8	10-4	6-8	12-18	32-30	30-32:
3. 3/2	20	14	26	-10	10-8	8-14	32-20	36-22:
4. 3/5	13	10	16	4-8	8-6	20-12	38-32	20-26:
5. 3/10	5	6	4	8-14	4-2	22-12	36-30	24-38:
6. 3/13	19	16	22	8-8	10-6	20-10	20-26	26-28:
7. 3/18	27	24	30	4-4	4-6	26-24	18-24	24-12:
8. 3/21	40	44	36	6-10	8-8	16-16	10-14	16-14:
9. 3/24	33	28	38	8-2	8-6	16-14	10-20	30-20:
10. 3/27	42	38	46	10-2	8-8	32-24	14-10	8-10:
11. 3/31	39	30	48	8-6	12-4	20-12	10-16	20-14:
12. 4/2	45	44	46	6-8	10-10	20-22	6-8	14-6:
Averages	25	23	28	6-7	8-7	18-16	20-21	23-19:
Moved forward to 9 feet								
13. 4/7	53	46	60	8-4	8-4	18-18	12-4	12-10:
14. 4/10	45	36	54	6-4	12-18	22-16	18-6	6-2:
15. 4/14	48	54	42	10-8	16-18	12-24	6-8	2-:
16. 4/17	46	40	52	14-6	16-10	22-18	4-14	4-:
Averages	48	44	52	9-5	13-12	18-18	10-8	6-3:
Moved back to original distance 13 $\frac{1}{2}$ feet								
17. 4/21	44	46	42	6-4	16-12	20-20	10-16	2-6:
18. 4/24	44	46	42	4-8	12-14	22-18	12-10	4-8:
Averages	44	46	42	5-6	14-13	21-19	11-13	3-7



#10 N.R.

DAILY RECORD SHEET

<u># 10, N. R.</u> subject	<u>4/14/31</u> date	<u>15</u> no. perf.	<u># 48</u> hits-H
1.	26.	51.	76. H
2. H	27. H	52. H	77.
3.	28.	53.	78. H
4.	29. H	54.	79.
5.	30. H	55. H	80. H
6. H	31. H	56.	81. H
7.	32.	57.	82.
8.	33.	58.	83. H
9.	34. H	59.	84.
10. H	35. H	60. H	85. H
11.	36. H	61. H	86. H
12. H	37. H	62.	87. H
13.	38. H	63.	88.
14.	39. H	64.	89.
15. H	40. H	65. H	90. H
16. H	41. H	66. H	91.
17.	42. H	67.	92. H
18. H	43.	68. H	93. H
19.	44. H	69.	94.
20.	45.	70.	95.
21. H	46.	71.	96.
22.	47.	72. H	97. H
23. H	48.	73.	98. H
24. H	49. H	74.	99.
25. H	50. H	75.	100.

#10, N.R. This subject was without any golf experience. He was an athlete, a varsity light-weight wrestler. He practiced twice a week at the long distance, very irregular at the beginning, and had the most difficult time of all to get into hitting form. He started with an upright stance, later he choked his grip on the club and stooped over considerably, using a short quick stroke. He was at all times trying his very best, very inquiring and analytical, experimenting a great deal in attempting to discover some stance and stroke that would lead to success. He gripped the club very hard and tired his wrists in the early performances in trying to get the proper loft. He made 18 per cent of his shots the first practice, went to 20 in his third performance, and down to 5 the fifth period. Thereafter he improved quite consistently.

During his fifth practice he said, "I cant keep all variables under control, when I attend to one the others are lost, "He thought possibly he was trying to remedy too many things at once. "Things just wont come- -first I hit too hard, then too easy or wide." Was bothered by sore arm, injury from wrestling. Sixth practice. Tries a new form- -grips club shorter, using a quick sharp stroke. Has no recognition of correct feel or set. He made a nice gain on his following practice and remarked that one thing would work for a while and then give out. When he dropped off on his ninth practice he said, "I am baffled as to how to shoot or what kind of stroke to take in order to hit consistently. I am not conscious of any particular right feel." Tenth practice. Subject felt fine and more confident, got a new

high score. "I'm positive now I can hit the hole quite often - -have gobben over that lost feeling."

Brought forward. Subject retained same stance, less snap in stroke. He felt that the opening appeared larger, there was more of it, he could see more of its depth and got sort of basket impression. "After I made a few shots quite easily I grew more confident. Its a more delicate shot- - but easier to sight." His first mark at the nearer distance was 8 more than any of previous scores. He didn't improve over his first score in the remaining three practices.

After returning to original, farther distance, he said, "It looks hard and far away. It all came back to me after a few shots. As soon as I get tense or tired I'm all off. I must remain relaxed- -then I can hold to the required coordinations longest."

TABLE XI

11, D. F. S. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits: 1st $\frac{1}{2}$	hits: 2nd $\frac{1}{2}$	% 1st zone	% 2nd zone	% 3rd zone	% 4th zone	% off rack
1. 2/10	18	22	14	14-8	14-10	6-14	20-24	24-30
2. 2/11	16	24	8	4-12	16-4	16-20	16-30	24-26
3. 2/13	29	24	34	12-12	24-14	18-16	12-12	10-12
4. 2/16	32	30	34	10-18	8-10	14-8	22-20	16-10
5. 2/18	25	18	32	10-12	20-18	18-12	18-14	16-12
6. 2/20	36	34	38	8-14	14-10	24-28	14-4	16-6
7. 2/23	40	44	36	16-8	12-22	20-16	6-12	10-8
8. 2/25	38	24	52	10-8	26-16	14-8	12-16	14-
9. 2/25	46	44	48	8-18	12-12	24-10	10-12	2-
10. 2/2	46	48	44	10-10	12-16	14-20	12-8	4-2
11. 3/4	29	20	38	4-6	20-14	18-10	24-18	14-12
12. 3/6	49	40	58	4-14	16-10	14-12	10-4	16-2
13. 3/9	52	56	48	10-12	12-12	14-18	6-8	2-
14. 3/11	46	42	50	6-12	20-10	18-12	8-10	6-4
15. 3/13	52	48	56	12-10	6-10	14-18	14-2	6-2
16. 3/16	32	30	34	10-12	10-16	16-18	14-16	10-4
17. 3/18	43	46	40	10-18	10-16	20-18	12-8	2-
18. 3/20	30	16	44	6-4	12-8	10-14	28-12	28-18
19. 3/23	47	44	50	14-12	14-10	12-16	8-8	8-4
20. 3/25	46	38	54	12-4	12-8	26-20	6-6	6-8
21. 3/27	28	28	28	6-8	16-14	24-24	12-8	14-18
Averages	37	34	39	9-11	14-12	17-15	13-11	11-8
Moved back to 13 $\frac{1}{2}$ feet								
22. 3/30	32	36	28	6-6	10-18	24-26	20-16	4-6
23. 3/1	33	36	30	4-10	6-10	16-26	18-18	20-10
24. 4/6	20	16	28	8-10	12-18	32-20	16-20	20-4
25. 4/8	23	22	24	8-6	4-14	26-24	24-18	16-14
26. 4/10	32	24	40	8-8	10-12	24-26	26-8	8-6
Averages	28	26	30	7-8	9-14	24-24	20-16	13-8
Moved forward to original distance 9 feet								
27. 4/13	38	40	36	6-10	16-12	12-12	20-18	6-12
28. 4/15	45	44	46	6-	10-16	14-14	12-18	14-6
29. 4/17	47	40	54	6-6	8-22	16-10	18-6	12-4
Averages	42	41	45	6-5	11-16	14-12	16-14	10-7

No of Correct Shots and Gross Errors

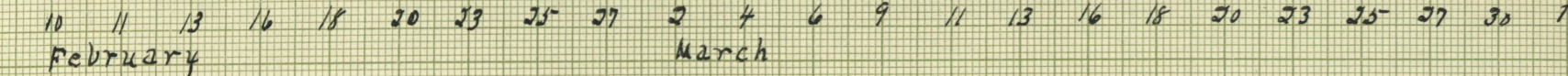
— Daily Performance-correct shots
— Daily Performance-gross errors

100
90
80
70
60
50
40
30
20
10
0

10 11 13 16 18 20 23 25 27 2 4 6 9 11 13 16 18 20 23 25 27 30 1
February March

Dates of Practice Periods

#11 D.F.S.I



% of Correct Shots and Gross Errors

100
90
80
70
60
50
40
30
20
10
0

1 6 8 10 13 15 17

Dates of Practice Periods

— Daily Performance-correct shots
— Daily Performance-gross errors

#11 D.F.S. II

DAILY RECORD SHEET

<u># 11, D. F. S. 3/6/31</u>		<u>12</u>	<u># 49</u>
subject	date	no. perf.	hits-H
1.	26.	51. H	76. H
2.	27. H	52. H	77.
3. H	28. H	53. H	78. H
4.	29. H	54. H	79.
5.	30.	55.	80. H
6.	31.	56. H	81.
7. H	32.	57. H	82. H
8.	33.	58.	83. H
9. H	34. H	59. H	84.
10.	35. H	60.	85.
11.	36.	61.	86. H
12.	37. H	62.	87. H
13.	38. H	63. H	88. H
14.	39. H	64. H	89.
15.	40. H	65. H	90.
16.	41.	66.1	91. H
17.	42. H	67.	92.
18.	43.	68.	93. H
19.	44. H	69.	94. H
20.	45.	70. H	95.
21.	46.	71. H	96.
22. H	47.	72. H	97.
23. H	48. H	73. H	98. H
24. H	49. H	74. H	99. H
25.	50. H	75. H	100.

#11, D.F.S. had never played golf of any kind. He took a very matter of fact upright position, partly facing the rack, not the conventional golf stance, that is, square with the ball. He gripped the club near the top, hands somewhat apart, and adopted a stroke that was more or less of a short quick scoop, which he retained throughout, even when moved back to another distance. His unusual stance and method of holding the club led to considerable topping of the ball. Trying to loft a ball into an opening was an altogether new experience to this subject. Due to defective vision he had never as boy played any of the variety of ball games. At the start the problem struck him as somewhat amusing, as fun, however he developed genuine interest in it as the difficulty of its solution became apparent. He practiced regularly 3 times a week at the short distance, on Monday, Wednesday, and Friday.

This subject just started to bang away, at the outset. He was quick to state that he felt a rise of tension with a series of hits. He got an idea of the correct form during the second practice period. He improved his score the third period and thereafter more or less consistently, with a few severe lapses, partly due to had colds. On the fourth practice he said, "The whole procedure is more natural, the club is becoming more a part of me. Didn't know for a while what led to so many failures; relaxed more and realized the cause, overtense." The subject felt that rapid shooting lessened irradiation, waiting for the ball seemed to lead to loss of set or necessary tension. Eighth performance. "If I could remain relaxed half the trouble would be solved. I

sought to make four straight,-- increased tension destroyed my coordination. Cant do anything about it! Admitted that adjustments were made on the basis of kinaesthetic image.

"After a series of hits I get to wondering how long I'll be able to keep it up, become too conscious of what I do and lose pattern. Rise of tension not always felt until a break occurs. The easiest shots go in."

February 9. Subject in fine mood. Decided at the outset to refrain from moving and talking during this performance. Shot a new high score. He looked less at the opening, and only after the ball was struck. Adjustments more basically kinaesthetic. Pattern persisted longer if position was maintained and no talking occurred. Subject was annoyed when the ball bounded back or became lodged in the rack. He also was of the opinion that the shooting tended to be more rhythmic when two balls were used. On a particularly good day he said, "Warming up for me amounts to nothing more than relaxing properly." At the start of his 18th practice period he stated that he was tired and sleepy. Got off to a bad start. Scored only once out of first 25 trials. Became desperate, changed form for first time, changed back soon. Became more tense as he continued to miss, shots were hard driven. Wasn't able to correct mistakes. "I attend to one thing and something else is wrong. I've tried everything and nothing works." Subject didn't settle down until he apparently gave up trying and fell into habitual form, then he succeeded in hitting a high per cent. Last practice before shift to farther distance. Subject not very alert. Was anxious to make a good score--tried very hard.

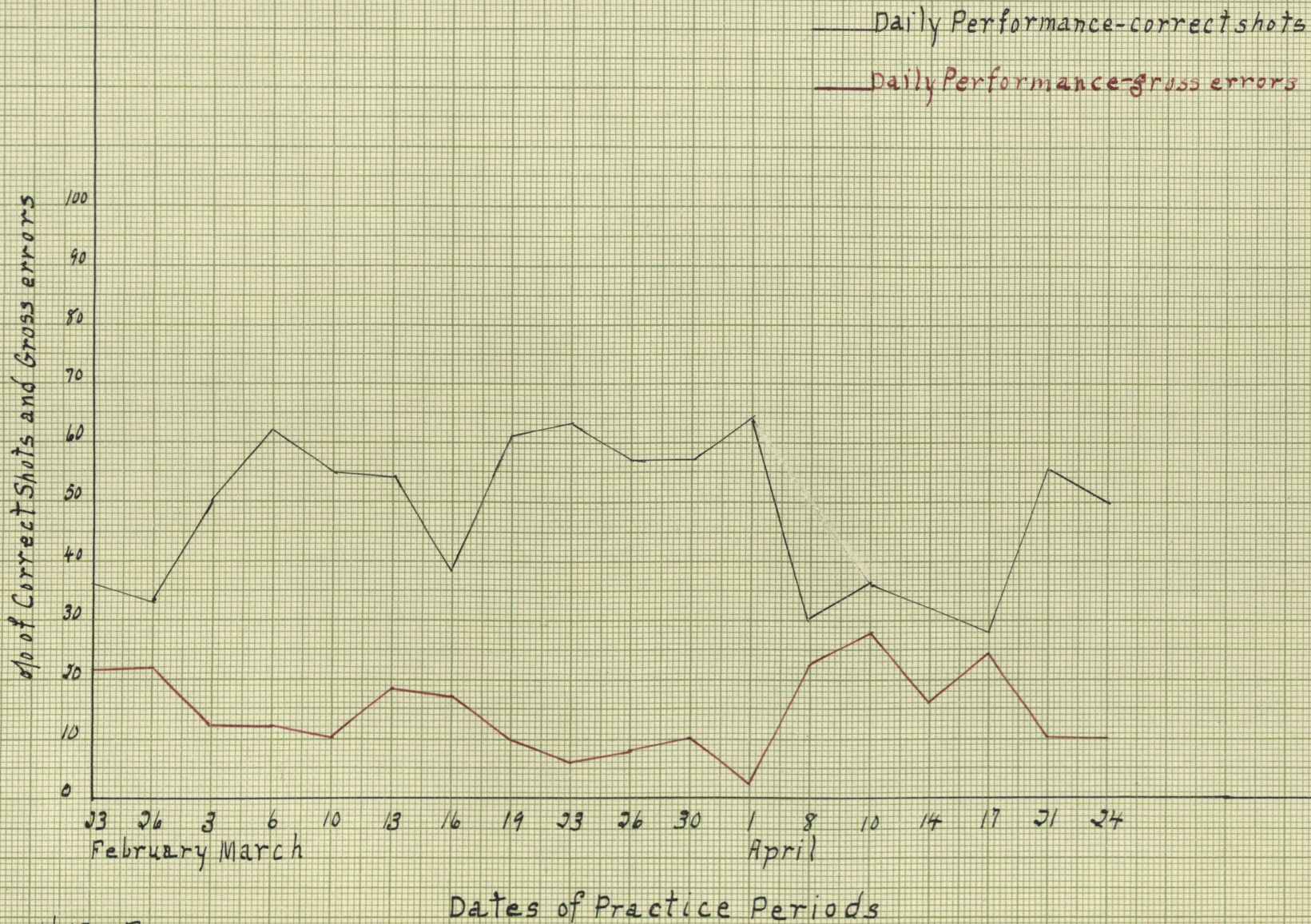
Became disgusted- -too tense, too conscious of performance. Made a score of 28, considerable below his average. Shifted back to farther distance. Opening appeared larger. "Situation much the same. It seems easier to hit, do not have to watch lofting so closely, a hard straight shot will go in." Overshoots many times. On the following practice he said, "The situation seems to have simplified itself, although I still can't make the finer adjustments consistently."

Returned to nearer position. "Appears real close now. The shot is different, more loft is needed." Final practice. "It's all coming back to me again. The easier I take it the more shots go in."

TABLE XII

12, W. B. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

: No. and date :	total hits :	hits 1st ¹ / ₂ :	hits 2nd ¹ / ₂ :	% 1st zone :	% 2nd zone :	% 3rd zone :	% 4th zone :	% off rack :
: 1. 2/23	36	36	36	10-10	14-14	18-20	6-10	16-10:
: 2. 2/26	34	20	48	10-16	12-14	28-16	18- 6	12- 8:
: 3. 3/3	50	60	40	10-14	12-16	8-16	8- 6	2- 8:
: 4. 3/6	62	68	56	8- 4	8-12	12- 8	- 8	4-12:
: 5. 3/10	55	52	58	8- 6	10-12	18-16	8- 4	4- 4:
: 6. 3/13	54	52	56	6- 8	12- 6	12-12	14- 8	4-10:
: 7. 3/16	38	44-	32	10-14	14-18	18-16	10-12	4- 8:
: 8. 3/19	61	60	62	6- 8	12- 4	20- 8	2-14	- 4:
: 9. 3/23	63	54	72	18-10	12- 4	8-12	4- 2	4- 2:
:10. 3/26	57	64	50	10-10	10-10	8-22	6- 4	2- 4:
:11. 3/30	57	52	62	6- 8	14- 4	22-12	4- 8	2- 6:
:12. 4/1	64	66	62	8- 4	8-18	16-14	2- 2	- :
: Averages	52	52	52	9-11	11- 9	15-14	7- 7	4- 6:
Moved back to 13 ¹ / ₂ feet								
:13. 4/8	30	30	30	12- 4	12-10	28-30	16-22	2- 4:
:14. 4/10	36	36	36	4- 2	10- 8	24-24	22-24	4- 6:
:15. 4/14	32	40	24	4- 4	4-16	36-40	16-12	- 4:
:16. 4/17	28	36	20	4- 8	12-12	32-28	12-24	4- 8:
: Averages	31	35	27	6- 4	9-11	30-30	16-20	2- 5:
Moved forward to original distance 9 feet								
:17. 4/21	55	54	56	14- 8	12-14	8-14	8- 4	4- 4:
:18. 4/24	50	42	58	10- 8	18-14	16-14	8- 4	6- 2:
: Averages	52	48	57	12- 8	15-14	12-14	8- 4	5- 3



#12W.B

Dates of Practice Periods

DAILY RECORD SHEET

<u># 12, W. B.</u>	<u>3/3/31</u>	<u>3</u>	<u># 50</u>
subject	date	no. perf.	hits-H
1.	26. H	51.	76.
2. H	27.	52.	77. H
3. H	28. H	53.	78.
4. H	29. H	54.	79.
5.	30.	55.	80.
6. H	31. H	56. H	81.
7. H	32. H	57. H	82.
8.	33. H	58. H	83. H
9.	34.	59.	84. H
10.	35.	60.	85. H
11. H	36. H	61. H	86. H
12. H	37.	62.	87. H
13. H	38. H	63.	88. H
14.	39.	64. H	89.
15. H	40. H	65. H	90.
16.	41.	66.	91.
17.	42. H	67. H	92.
18. H	43. H	68.	93.
19. H	44. H	69.	94. H
20. H	45. H	70. H	95. H
21. H	46. H	71.	96. H
22. H	47.	72.	97. H
23.	48. H	73.	98.
24.	49.	74.	99.
25. H	50.	75.	100. H

#12, W.B., was the only subject to shoot above thirty the first practice. His practices were irregular twice a week, 100 trial per period. He gripped the club long and did not stoop over very much. Feet were close together. He didn't move from position as often as some of the others and preferred at the outset to use but the one ball. Using a long stroke he put very little force into his swing, the drop of the club was about sufficient. His strokes were free, deliberate, well balanced, and rhythmical. Third practice, feels fine. Intends to beat former score. Does so by 16. Is very careful about keeping in position. Following a shift in grip he does badly, "Cant find just how I held it. When I think about my form too much I often overshoot. I dont have a clear image, merely let the club drop, try to repeat successful movements." Came within two points of his best score the fourth practice. Wished to reach a new peak on seventh performance. Started poorly and became greatly provoked. "I dont know where to stand, I seem lost. I cant stand up to the ball right- -cant get going, dont/understand it." Made 38. On the following performance he shot 61. Tenth practice. Did remarkably well the first half. He got to listening to a speaker in a room below and couldn't concentrate on the ball. "I just can't swing my club. Have lost something I cant recover. If I try to correct distance I miss direction." Shot above average score. Day of best mark. Subject said he fell easily into rhythmical swing. Tried to repeat the strokes that brought success.

Moved back to farther distance. He made the first

few and then fell off badly. He couldn't get the distance. It appeared to him as if he were still shooting for the smaller hole. Felt cramped by the nearness of the wall. Tried hard during the following practices, thought he would do better. Couldn't bring his shots down. "For some reason I can't get the hang of shooting at this distance." Was very angry at not being able to improve. Upon returning to the nearer distance he came up to his previous average very easily.

TABLE XIII

13, A. P. Number and date of performance, per cent of hits, shot dispersion by zones in each half period, and final averages.

No. and date	total hits	hits:1st $\frac{1}{2}$	hits:2nd $\frac{1}{2}$	% 1st zone	% 2nd zone	% 3rd zone	% 4th zone	% off rack
1. 3/5	22	36	8	10-8	14-8	16-20	10-36	14-26
2. 3/9	18	18	18	10-8	4-12	24-24	26-24	16-14
3. 3/16	41	42	40	12-12	14-8	18-16	6-16	6-18
4. 3/18	46	46	46	6-12	10-6	18-10	12-16	8-10
5. 3/20	48	42	54	4-12	14-10	10-8	16-8	14-6
6. 3/23	40	28	52	20-12	8-10	22-10	10-4	12-12
7. 3/24	57	52	62	10-10	10-8	14-8	12-6	2-6
8. 3/26	54	50	58	8-18	10-8	14-20	6-4	4-
9. 4/1	60	58	62	10-8	16-14	12-14	2-2	2-
10. 4/3	52	54	52	6-18	8-14	22-10	10-6	-2
Averages	43	43	44	10-12	11-9	16-14	11-12	8-8
Moved back to 13 $\frac{1}{2}$ feet								
11. 4/14	32	28	36	2-8	12-8	20-24	26-20	12-4
12. 4/16	36	36	36	4-10	16-8	24-26	10-10	10-10
13. 4/17	40	34	46	8-4	14-12	24-12	12-18	8-8
14. 4/20	39	32	46	6-16	18-12	20-16	12-8	12-2
15. 4/21	43	40	46	8-6	14-12	24-20	12-12	2-4
16. 4/23	45	38	52	6-10	14-12	20-16	22-10	-
Averages	39	35	43	5-10	14-10	22-19	15-13	7-4
Moved forward to original distance 9 feet								
17. 4/27	52	56	48	8-4	8-20	16-24	8-4	4-
18. 4/29	52	44	60	8-10	16-6	28-12	4-8	-4
Averages	52	50	54	8-7	12-13	22-18	6-6	2-2

No of Correct Shots and Gross Errors

100
90
80
70
60
50
40
30
20
10
0

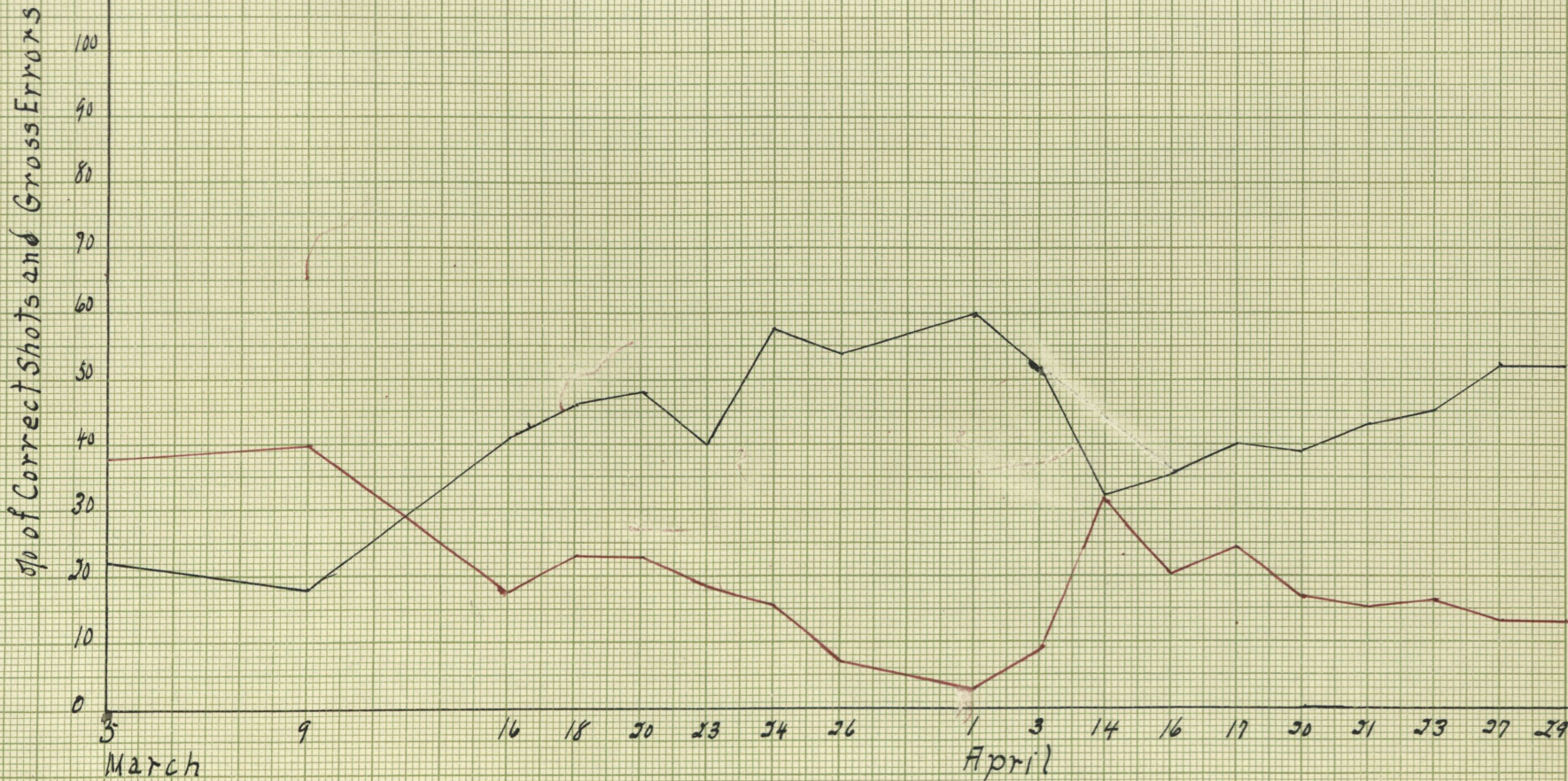
— Daily Performance - correct shots
— Daily Performance - gross errors

5 March 9 16 18 20 23 24 26 1 April 3 14 16 17 20 21 23 27 29

Dates of Practice Periods

#13 A.P.

KEUFFEL & ESSER CO., N. Y., NO. 358-14
Millimeters, 10th lines heavy.



DAILY RECORD SHEET

<u># 13, A. P.</u> subject	<u>4/8/31</u> date	<u>10</u> no. perf.	<u># 52</u> hits-H
1.	26. H	51. H	76. H
2. H	27. H	52. H	77. H
3.	28.1	53. H	78.
4. H	29. H	54. H	79.
5. H	30. H	55.	80.
6.	31.	56. H	81. H
7.	32. H	57.	82.
8. H	33. H	58.	83. H
9. H	34.	59.	84.
10. H	35. H	60.	85. H
11.	36. H	61.	86.
12.	37. H	62. H	87.1 H
13.	38.	63. H	88.
14.	39.5.	64.	89. H
15.	40. H	65. H	90.
16. H	41. H	66.	91.
17.	42.	67.	92.
18.	43. H	68.1 H	93. H
19.	44. H	69. H	94. H
20. H	45. H	70.	95. H
21.1	46.	71.	96. H
22.	47.	72.	97.
23. H	48. H	73. H	98. H
24. H	49. H	74.	99.1 H
25. H	50.	75. H	100.

#13, A.P. Like most of the other subjects composing this group, this ^{one} also was inexperienced in golf, the problem was entirely new. His practices were irregular, 2 and 3 a week, 100 trials. He took a good square stance, facing the ball, feet somewhat spread, club gripped high. His back-swing was short but his follow through rather long. In fact he carried the ball way up on his club head. Except for minor modifications this subject retained much the same stance and form throughout. At the outset this subject was very tense which made it very difficult to get an easy loft to the ball. His hard straight drives were evidence of his tenseness, as were the frequent strains in his back. When the hard driven balls proved inaccurate he eased up on the stroke and got better results. He felt at the outset, and reaffirmed it later, that retaining a constant position was less disrupting to the proper feel.

His third practice after a week interval was a remarkable improvement over the second. Until near the end, when he tired, his coordination was good. He was shooting with less force and concentrated intently upon every stroke, following through with his entire body. Fourth practice. Feeling more confident. "I am getting the feel of it more and more- -know just about how much force to put into stroke to score." His short stroke had resolved itself into more of a short chop with less follow through. March 20. "Feel fine. Dont believe I'll beat my last score though." Did so by 2 points. He was shooting very deliberately and admitted greater ease of getting into a proper set. Bears to move

from position lest he lose the pattern. Still, he was learning to relax between strokes. Match 24. "Feel rather tired today." Reached a new high score. Feels a rise of tension with a series of hits, same with a string of misses. "I miss some due to carelessness. Had a good kinaesthetic image today, could tell it readily when I had it." Eighth practice. Subject in high spirits. Shot with smoothness and regularity. Felt less strain in back, more relaxed.

Ninth practice. Reaches best score. Looks less at the hole, concentrates more on the ball. Finds himself able to place shots while correct pattern persists. Subject did very well until he reached his 80th stroke when he was forced to relax to relieve growing strain in his back. An erratic period followed, didn't recover pattern.

Moved back. Commented upon the fact that the present opening looked so much larger. "Should be easy to hit into." The first few shots were long, then varied from long to short. "I don't know how hard to hit, do not have the feel at all. When I get into a good series it seems best to shoot rapidly. Overtrying doesn't do any good, get all muddled up." April 21. "Should do better this time, feel lots better than I have for some time. At times I can put them in without trying. Whenever I get over anxious I'm very apt to miss." Last practice at longer distance. Subject appeared very confident. "On some days when I watch everything carefully I'm almost certain of scoring at will, and then again I'm all off." Best score at this distance. Brought forward again. "Have a better feel of it at this distance, know the amount of force to put into the stroke. Seems easier now than it did before. I don't have to spot the ball so accurately."

TABLES AND CURVES--EXPLANATION
AND DISCUSSION.

The results of the performances of each subject are shown both in graphic and tabular form. In tables one to seven, comprising the results of the relearning group, preceding the data obtained in the present experiment, are three samples of the subject's performance during the original training period, as recorded by Roff. The samples selected represent in each case the highest of the first three scores; representative performances at about the half-way mark in the training period, and the best score of three performances during the final week.

The data as recorded during the relearning period follows next. First the results obtained at the original distance and then the data secured when the subjects were moved back to a point fifty percent farther away from the target, the size of the hole being proportionately greater in area. It was not believed necessary to bring the people forward again to the original distance since Roff had proven conclusively that in returning to the first or training distance the subjects suffered no impairment of efficiency.

The last six tables, eight to thirteen, give the records of the new people used. The data are shown just as in the first group; results obtained during the initial training period at the nearer or farther distance; then the results as recorded when the subjects were moved back, and

forward; and finally, the results when the subjects were brought to their respective starting positions.

The original learning curve illustrated by the solid black lines in each of graphs one to seven, of each of the relearning group is shown together with the relearning curve, represented by the broken black line. The latter curves are comparatively short. In addition, on each of graphs one to seven, appear two curves that are illustrative of the decline and the variation in number per performance of the gross errors. The solid red curve is an illustration of this during the learning period and the broken one during the relearning period. The second group of graphs, eight to thirteen, naturally have but one each of the learning and gross error curves, illustrated by solid black and red lines, respectively. In plotting the points for the gross error curves not all the misses or failures were counted, only those that missed the target by more than eight inches. It was assumed that any ball that landed off the rack, or more than eight inches from the edge of the hole, under the conditions of this experiment was poor coordination on the part of the performer. The eight inch zone limit was not an entirely arbitrary selection. The dimensions of the two openings used fell roughly between fourteen and nineteen inches, so that eight inches approximates half the distance across the opening.

The hits taken alone in this experiment, and in similar ones, are not sufficiently indicative of the performer's

real ability and progress, that is, they are not a true measure of his total number of well coordinated strokes. Just the slightest error or veering in direction may lead to failure yet the stroke itself may have been perfectly executed with reference to proper loft and distance. It might be suggested that shots falling short or going long would scarcely come under the misdirection category, which is true. Nevertheless the eight inch zone limit extended in all four directions. It needs scarcely to be added that not nearly all of the successful shots resulted from perfect muscular coordinations.

A further comment on the 'gross error' curves. They illustrate remarkably well what the results of other motor learning experiments have suggested, namely that when a subject is not well or has an off day, that there is almost invariably a tendency to disintegration of muscular pattern. Specific observations made by the different subjects during times when they had an injury, were not feeling well, or had an off day, support the above conclusion. #3, T.P. shooting at a time when he had a bad cold said, "I find the pattern very uncertain and unstable, I have it one moment and lose it the next." #4, B.S. in attempting to perform after having suffered a minor arm injury found himself unable to regulate the force of his stroke and also admitted not having had a clear pattern. On November 19, #6, S.G. shot a low score following a good day. She admitted being off usual form, couldn't seem to settle down, try as hard as she might.

On March 16, 20, and 27, #11 D.F.S. was much under his usual form although he tried his very best. #8 R.B. experienced the same thing on March 9. Additional instances could be cited. One would be rather led to believe that after proficiency has once been attained that only the ability to make the finer coordinative adjustments would be disrupted, that is, as long as there is nothing seriously wrong with the subject. Such is not true however. When the subject fails to hit the target he also makes an increasing number of bad shots. To the writer it appears as very substantiating evidence of the whole individual active in every response, and that when counter stresses of any kind are set up which the organism cannot overcome there is a reversion due to probable deficiency of energy, to less finely differentiated types of response.

I. RETENTION OF SKILL

The subjects comprising the relearning group without exception showed remarkable stability of motor pattern. As regards the complete numerical facts for this group tables of results one to seven should be consulted. A few significant points revealed by a study of the statistical data may be noted.

If an average is taken of the total number of hits of the three samples given, which are fairly representative to the scores of the original training period, it will be observed that the initial relearning score is either about equal to this average or well above it. In case of subject # 1, R.H.W., such a comparison reveals the two to be equal, 67 and 67. Subjects # 3, T.P., #6 S.G., and # 7, E.J., exceed their averages by 19, 3, and 8 points, respectively. Subjects # 5, C.W., #2, B.M.M., and #4, B.S., fall short of their averages by two, eight, and nine points, respectively. Comparison of the averages obtained during the final week of training under Roff, with the average of the first week of relearning period reveals a slight loss in proficiency in every case. "#1, R.H.W., came within five points of this average; #7, E.J., within six; #3, T.P., and #4, B.S., within eight; #2, B.M.M. and #5, S.W., within fourteen; and #6, S.G., within ~~s~~ighteen points. The averages that Roff obtained are not shown here but his records were consulted to make comparisons. What has been pointed out means in short, that the patterns formed in the learning of this problem are rela-

tively permanent, at least were not greatly impaired during the lapse of about six months. Further evidence of retentiveness of motor patterns comes from the subjects themselves, as will be found in the introspections.

Since Roff did not enlarge the opening when he moved his subjects back to the $13\frac{1}{2}$ feet distance, fair comparison cannot be made of the relative stability of the motor patterns at this distance. Suffice it to say that a comparison of averages reveals the fact that four out of the seven retested at this farther distance, with the size of the opening increased proportionately, scored considerably higher even after a lapse of about six months, than they had during the training period at the same distance. If due allowance were made for the enlarged size of opening results similar to those in the preceding paragraph would be probable?

The question suggests itself in how far is the permanency of a pattern a function of the length or thoroughness of the original training period. Nothing very definite, bearing on this particular question, was found in the literature. A number of experimenters in committing their subjects to retests at varying intervals have found a decided gain in proficiency. Swift's (34) subjects when retested at monthly intervals rose to new peaks each time. Downey and Anderson (9) found considerable retention of skill after a lapse of practice of two years. Cohen(8), upon retesting his subjects $8\frac{1}{2}$ months after the end of an experiment in throwing balls at a target, found they performed better than at the close

of practice. Braden(3) in following up the retentiveness of skill of subjects used in a ball tossing experiment, found the relearning very rapid after a lapse of 22 months and 11 days. In a second relearning checkup, seven months later, the subjects showed a marked improvement over the first re-trial. Johnson (17) similarly found that people, who had learned to walk the tight wire two years before, could walk the same wire perfectly upon the first retrial without having practiced any during the interval. The question raised above is not answered by any of the studies referred to. As far as the results obtained from the relearning group in this study are concerned, no correlation between the total number of periods practiced during the training season and the amount of retentiveness is evident. Not all the subjects who had trained the longest made the best scores upon being retested. Neither did the longest trained subjects progress more rapidly after repeated practices. Had the conditions under which the relearning of these subjects took place been a bit more satisfactory some positive evidence bearing on this might have been secured.

2. DISTRIBUTION OF SHOTS

In practically all motor learning experiments, be it tapping, dart throwing, ball-tossing, et cetera, the correct responses have been observed to be serially distributed taken over a total learning period. What is meant is that a series of correct responses will follow consecutively, interrupted perhaps by an equally long series of failures. Not only do the correct responses come in a series but it has also been observed that the series appear more or less periodically, that is to say, in certain temporal rhythmic order. It may reasonably be stated that all progress is rhythmic. In this experiment, as also in Roff's, the series distribution of successful shots was very evident. The accompanying samples of performance record sheet, numbers 1 to 13, demonstrate this fact. In order to show a fair distribution of both hits and misses the records selected are such as contain about an equal division of both.

Roff found a rough correlation between length of series and total daily score. The same generalization could be made from the results secured in this study. Roff was convinced that the most skillful subjects are able to make the longest series of hits. This is true only in a general way, under ideal conditions perhaps always. However, when applied to individual cases under a variety of conditions it does not hold. Some very skillful subjects become so tense following a series of hits that they cannot go on without the

relaxation which an occasional failure brings. Again some skilful subjects, rather highly temperamental under unsatisfactory and disturbing conditions perform very badly. So length of a good series not only varies with the skill of the performer but also with general stability.

The most adequate explanation of the series, which recent investigations seem to corroborate, is a physiological one, according to which the series are attributed as due to functional rhythms of neuro-muscular activity. This appears especially evident where performance is sustained over comparatively long periods without rest or interruption. Within limits the length of a series of hits may be controlled, that is, by voluntary relaxation when tension rises, by a pause, or by interruption. These neuro-muscular rhythms are to some extent, or maybe entirely, a function of stimulation imposed and, to the extent that the stimuli may be varied, the distribution of the good and bad responses may be modified.

3. DISPERSION OF SHOTS

Roff found, as have others observed, that with the increase of perfect trials there was a corresponding increase in accuracy generally. It seems more logical to put it in another way, namely, that with the development of muscular control and more perfect coordination the subject improves in his total performance, hence fewer shot are bungled and the number of hits and close ones naturally increase. The individual performance tables as well as the accompanying dispersion charts, for subjects 8 to 13, show clearly this very point, a centralization of shots with the increase of proficiency. The tabulated data serve to substantiate what Roff indicated, that after a number of practices there is, first, a decided falling off in the number of widely scattered shots. At this time there is scarcely any fluctuation in the total number of shots falling within a proximity of about 8 inches of the target. It is only after the subject becomes adept at placing the ball and the widely scattered shots have been reduced to a minimum before a noticeable shifting inward starts from this zone, and the last to thin out are those that strike at the very edge of the opening. A study of a few of the records made by #1, R.H.W., table I, the second half of performances number 7 and 11, illustrate this closing in phenomenon.

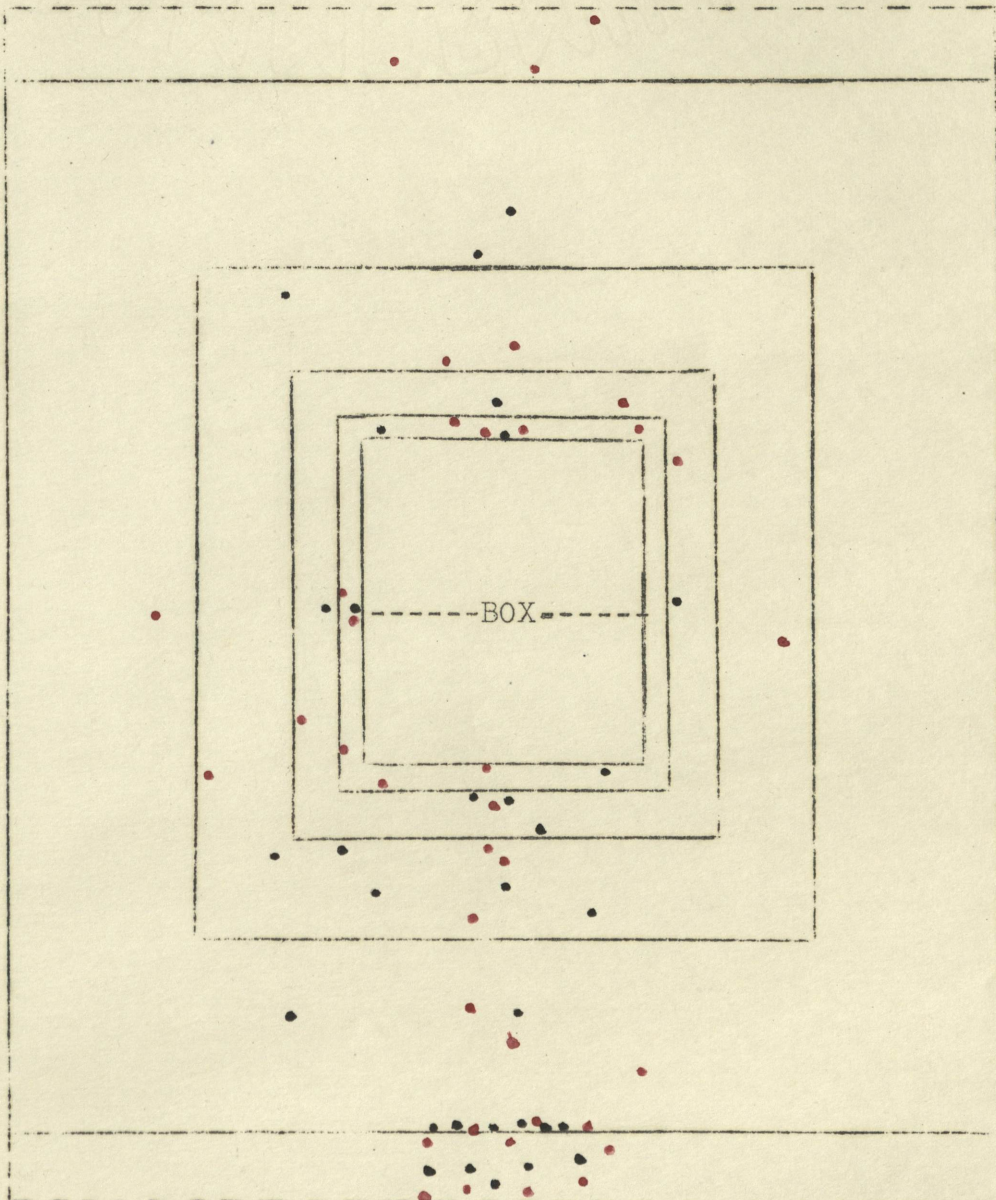
The change, that takes place with practice with a stimulus arrangement as presented in this experiment bears evidence of the fact that skill grows out of a gross or crude mass activity as a consequence of a process of differentiation.

The subject perceives the goal, reacts with what organization he possesses, even though cumbersome; much like a body of recruits at the beginning of a training period, knowing what to do and the end sought but failing in precision and correct execution due to insufficient stimulation and maturation. A recruit's initial attempts are not random or trial and error, every movement is made with reference to an end. Similarly, the subject's first reactions though not well organized with reference to the goal present a pattern of behavior that has some organization and is directed toward an end. With continued stimulation the gross pattern is markedly influenced, antagonistic musculature realign themselves and the conflicting stresses become attuned, so to speak. With the lapse of time maturation assists materially in this realignment of energy and as a result the organization of response patterns become less consciously mechanical, more highly complex, leading thus to a greater number of finer coordinations and adjustments. In the end, whether or not a high degree of proficiency has been attained with respect to the particular situation the reaction is still one of the whole being acting. The reactions do not become mechanized. Let the subject experience a so-called off day, fatigue, illness, or become distracted, and the finer coordinations suffer at once, there is a reversion to the more crude that can function with less energy. On the theory of performed pathways nothing of the kind would of necessity follow. The whole conscious organism is concerned with every response, and when disturbed the whole organism suffers, although the resultant effects need not be and are not equally evident. Through voluntary effort conflicting tensions may, to some extent, be made to dissipate themselves in different ways.

SHOT DISPERSION CHART

R. B. # 8
subject

3 # 31
no. perf. hits

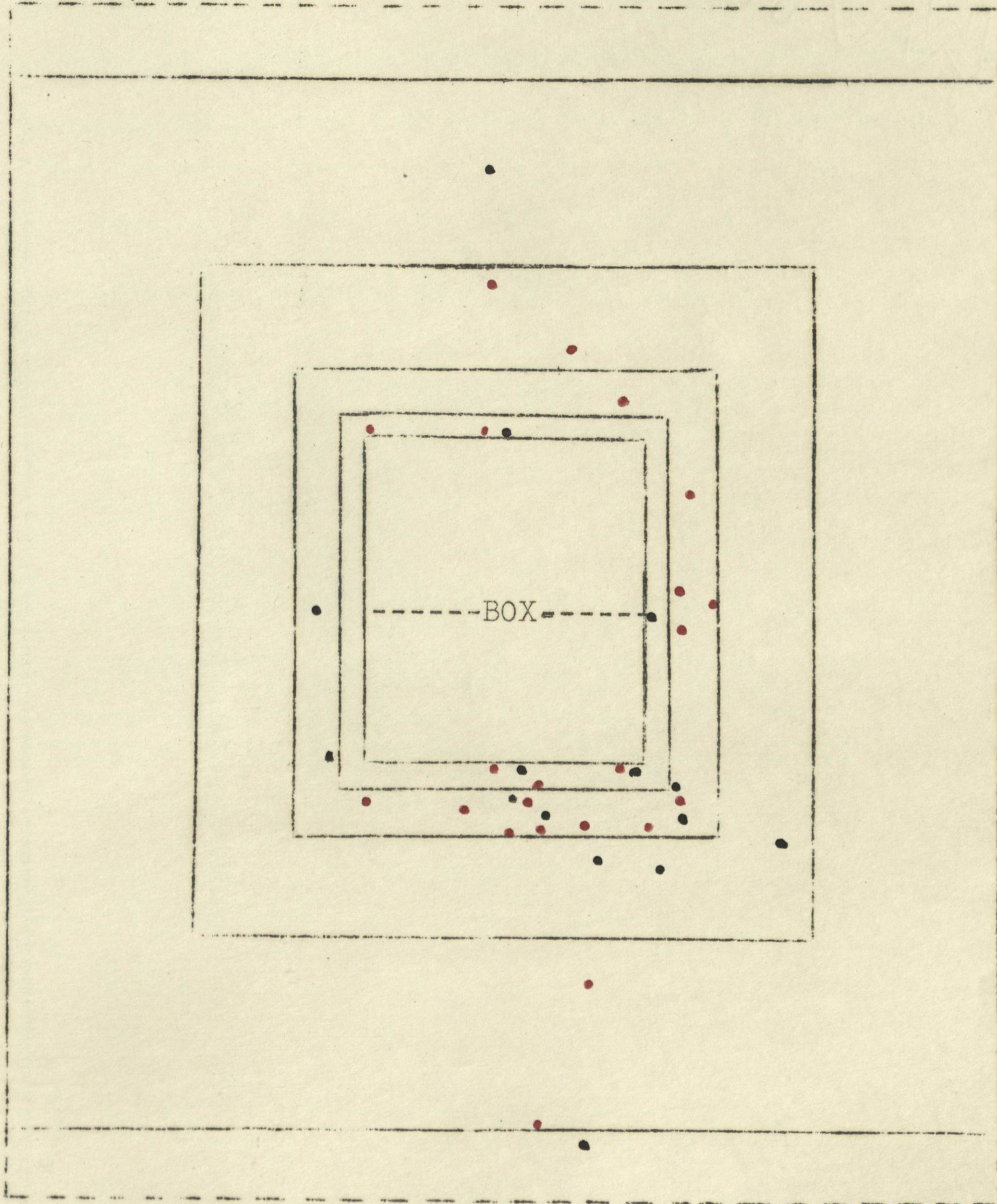


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

R. B. # 8
subject

8 # 63
no. perf. hits

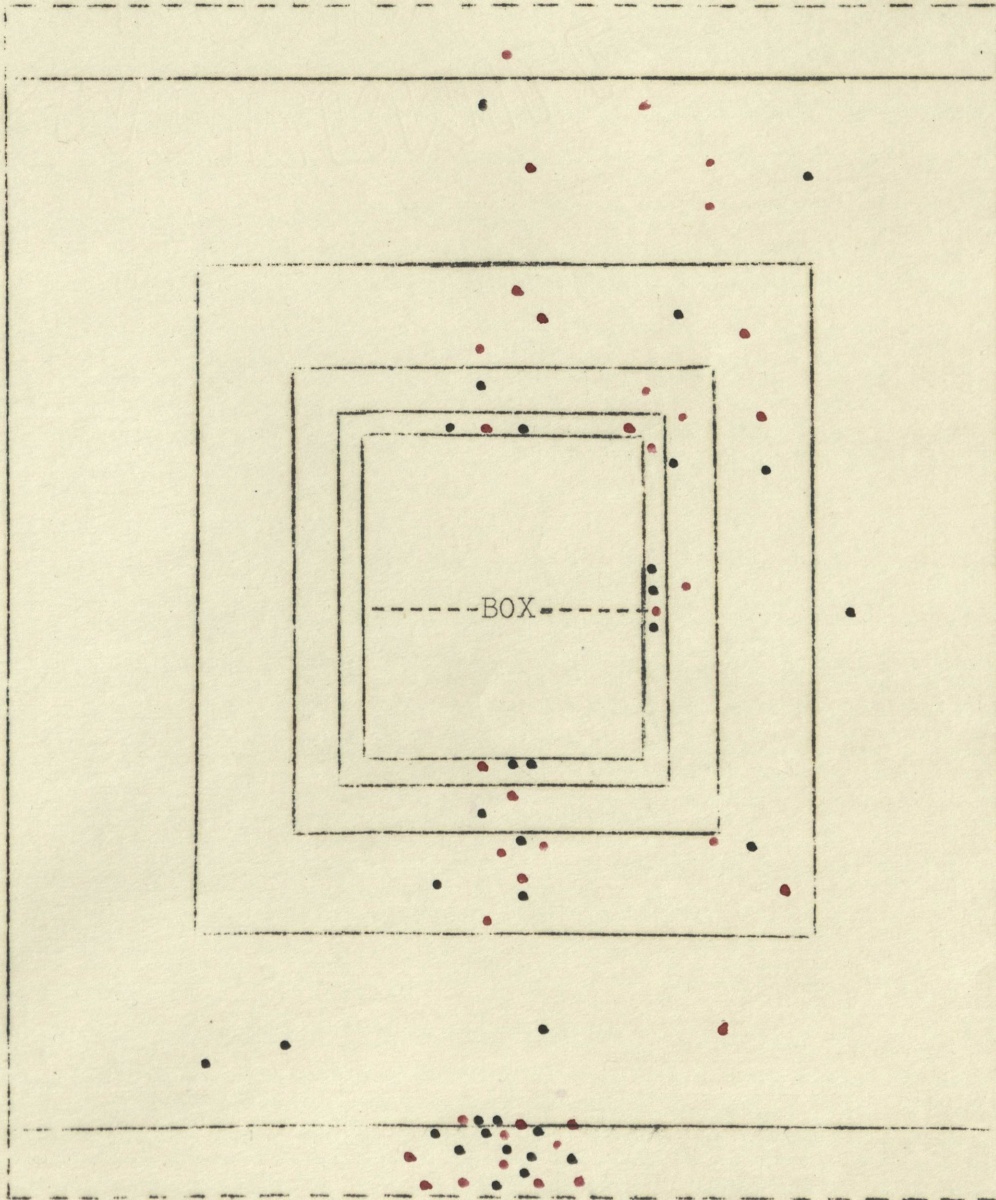


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

M. M. # 9
subject

1. # 30
no. perf. hits

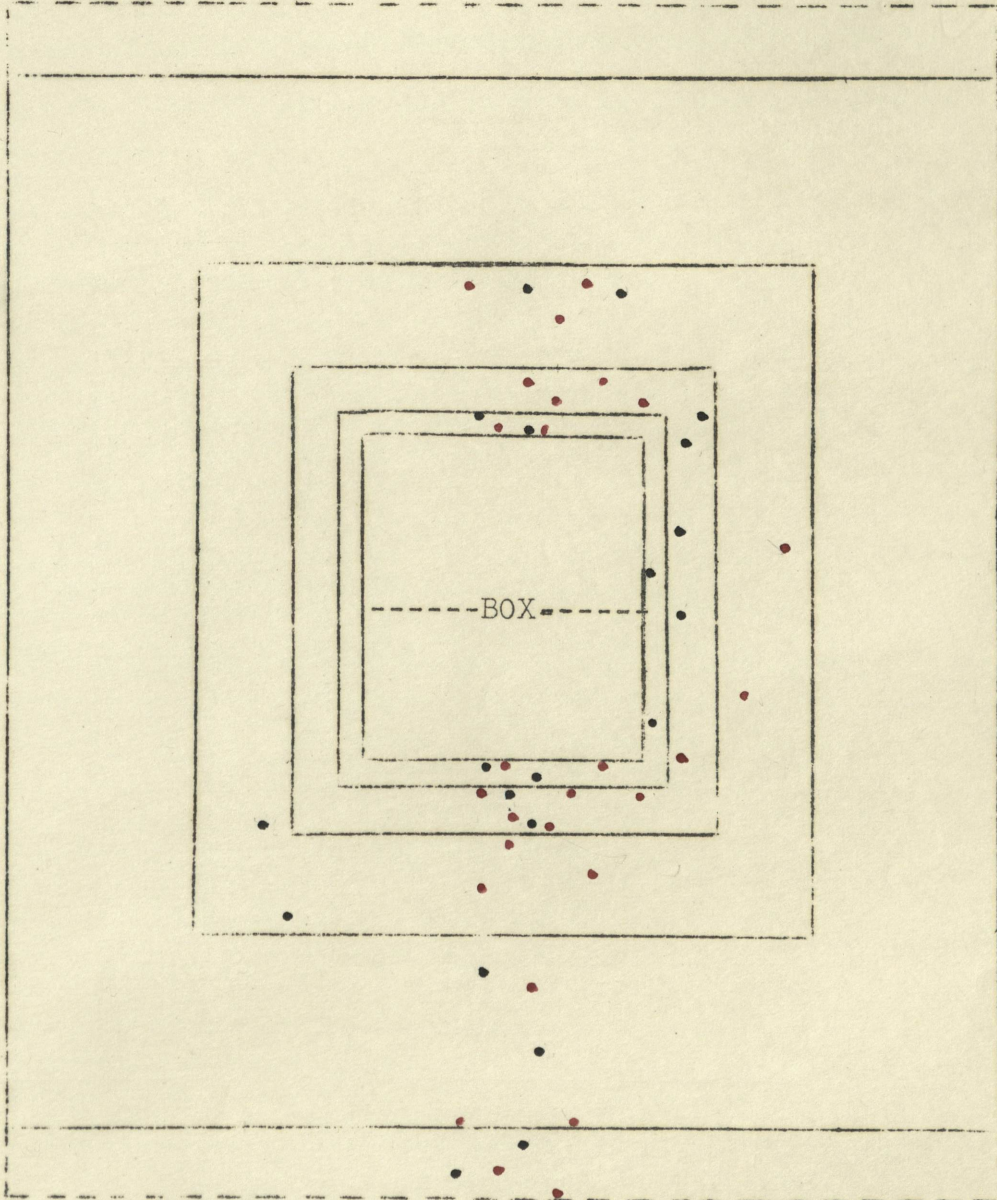


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

M. M. # 9
subject

9 # 54
no. perf. hits

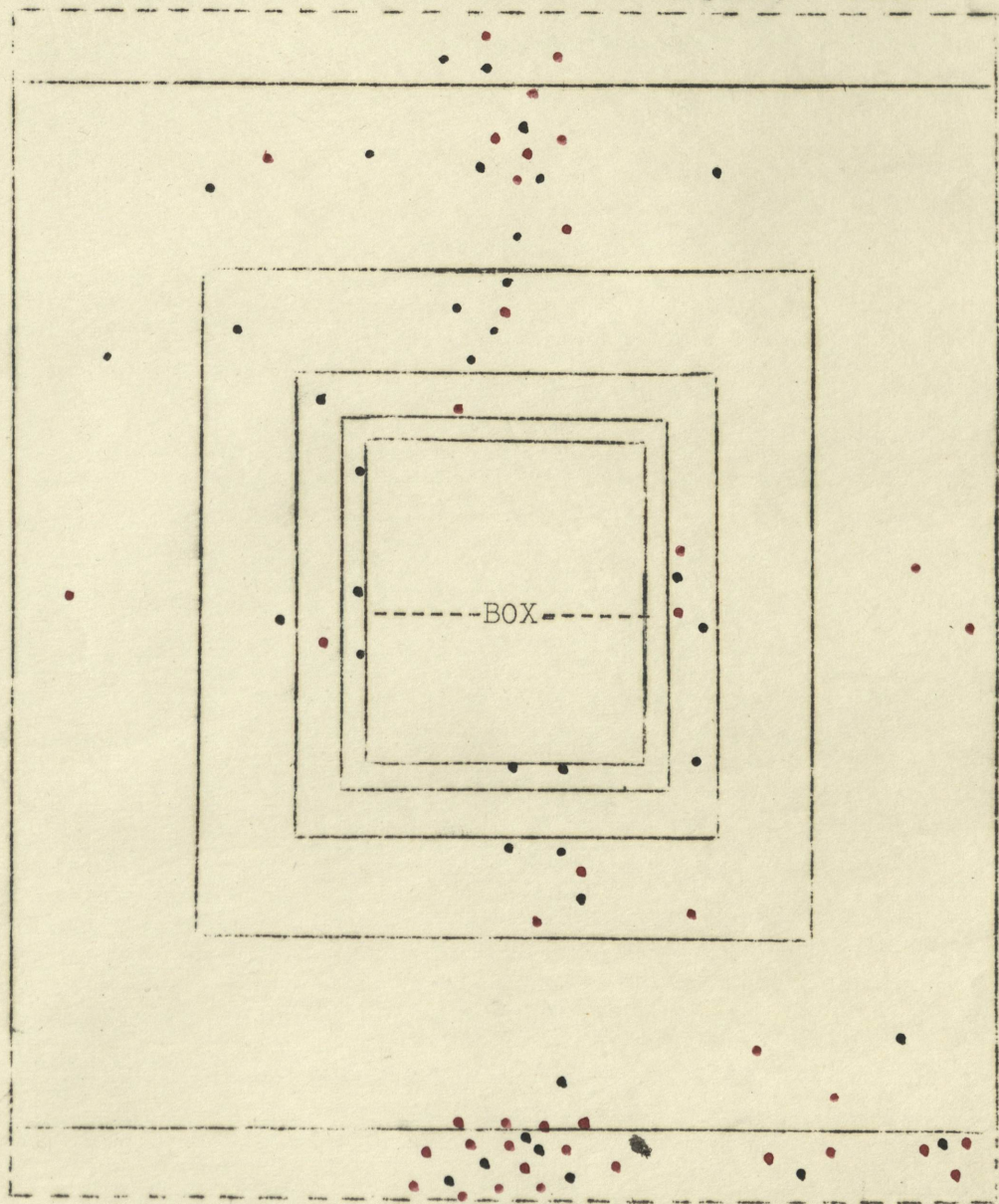


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

N. R. # 10.
subject

1. # 18
no. perf. hits

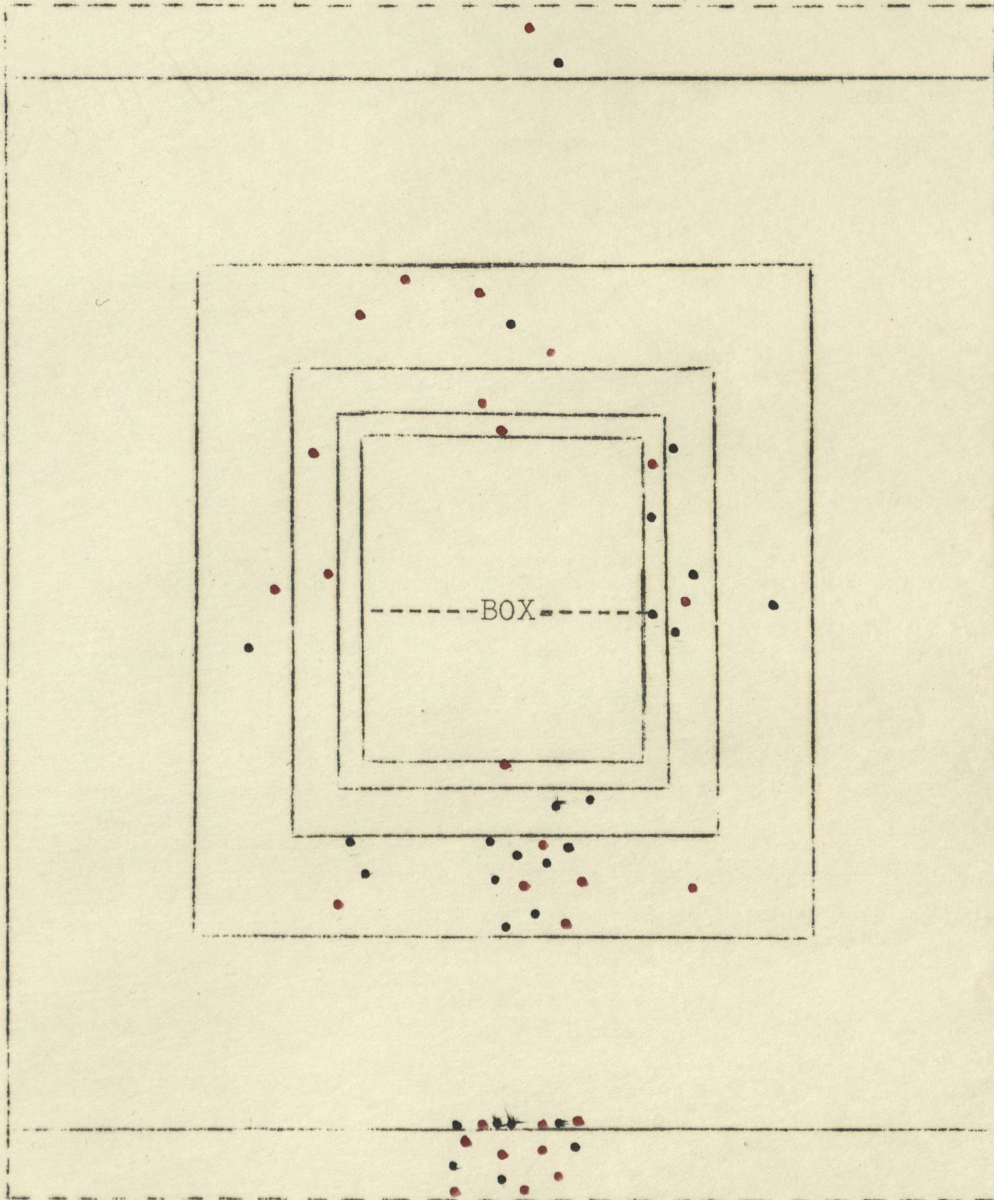


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

N. R. # 10
subject

12 # 45
no. perf. hits



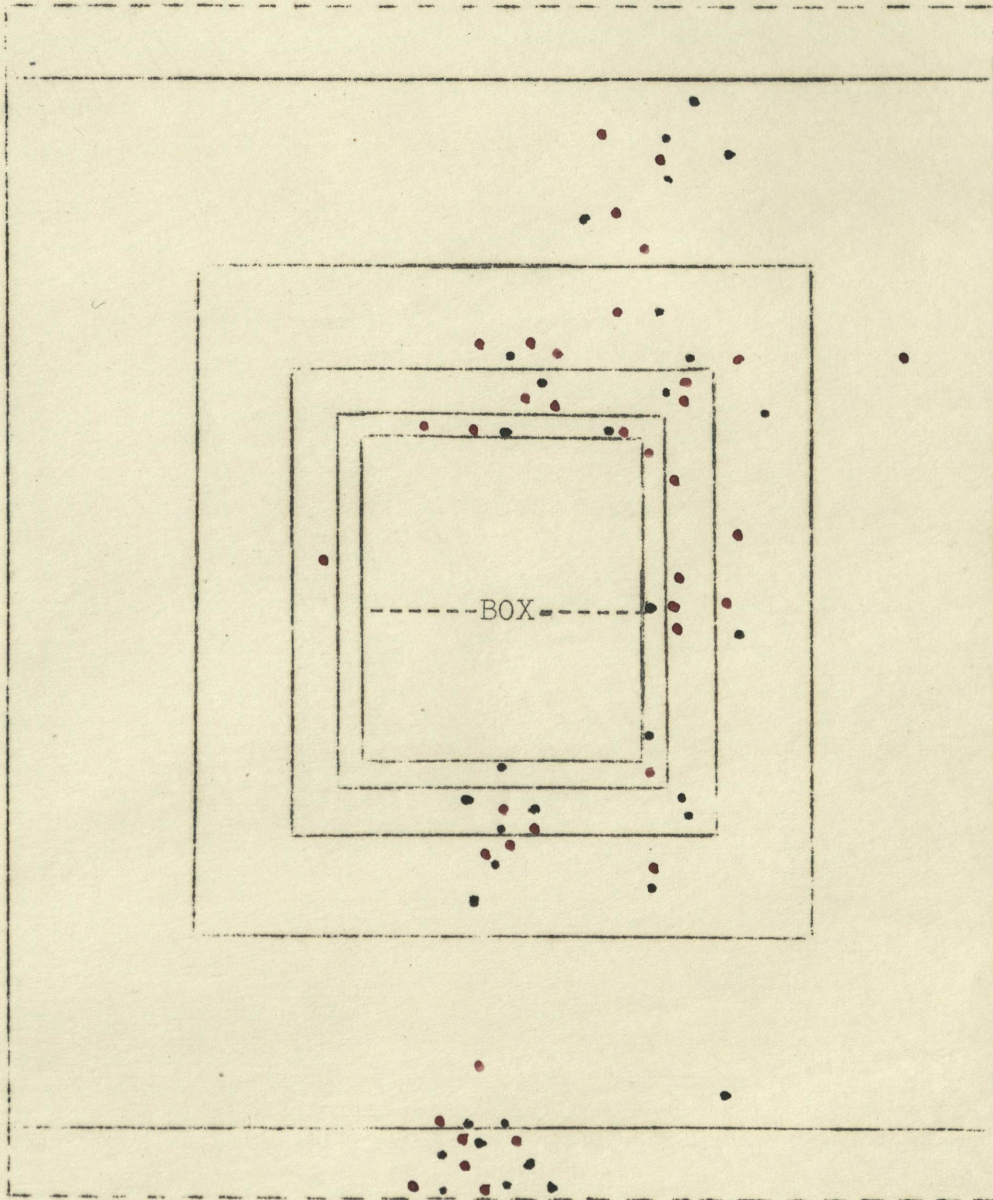
Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

D. E. S. # 11
subject

3
no. perf.

29
hits



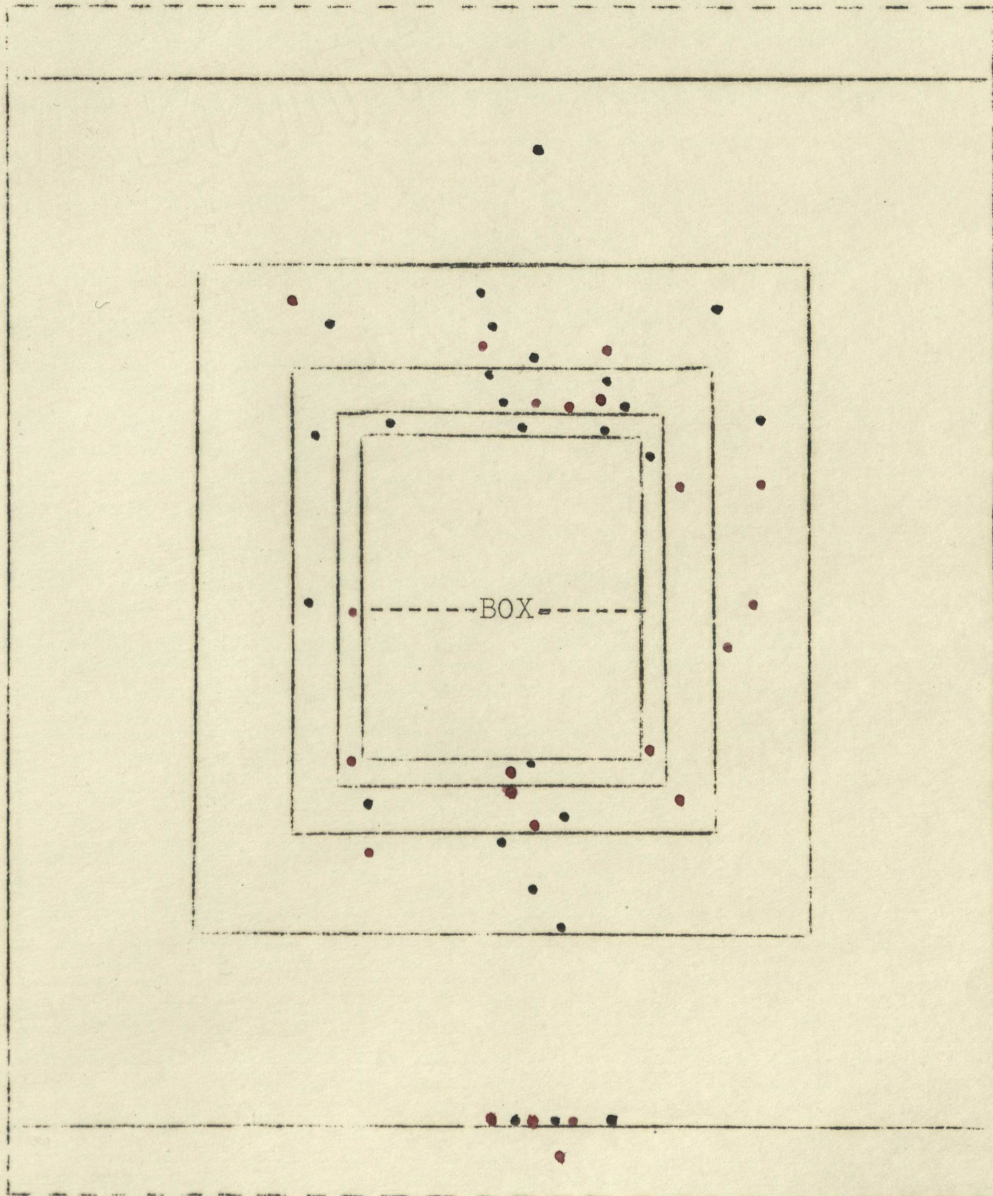
Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

D. F. S. # 11
subject

13
no. perf.

52
hits

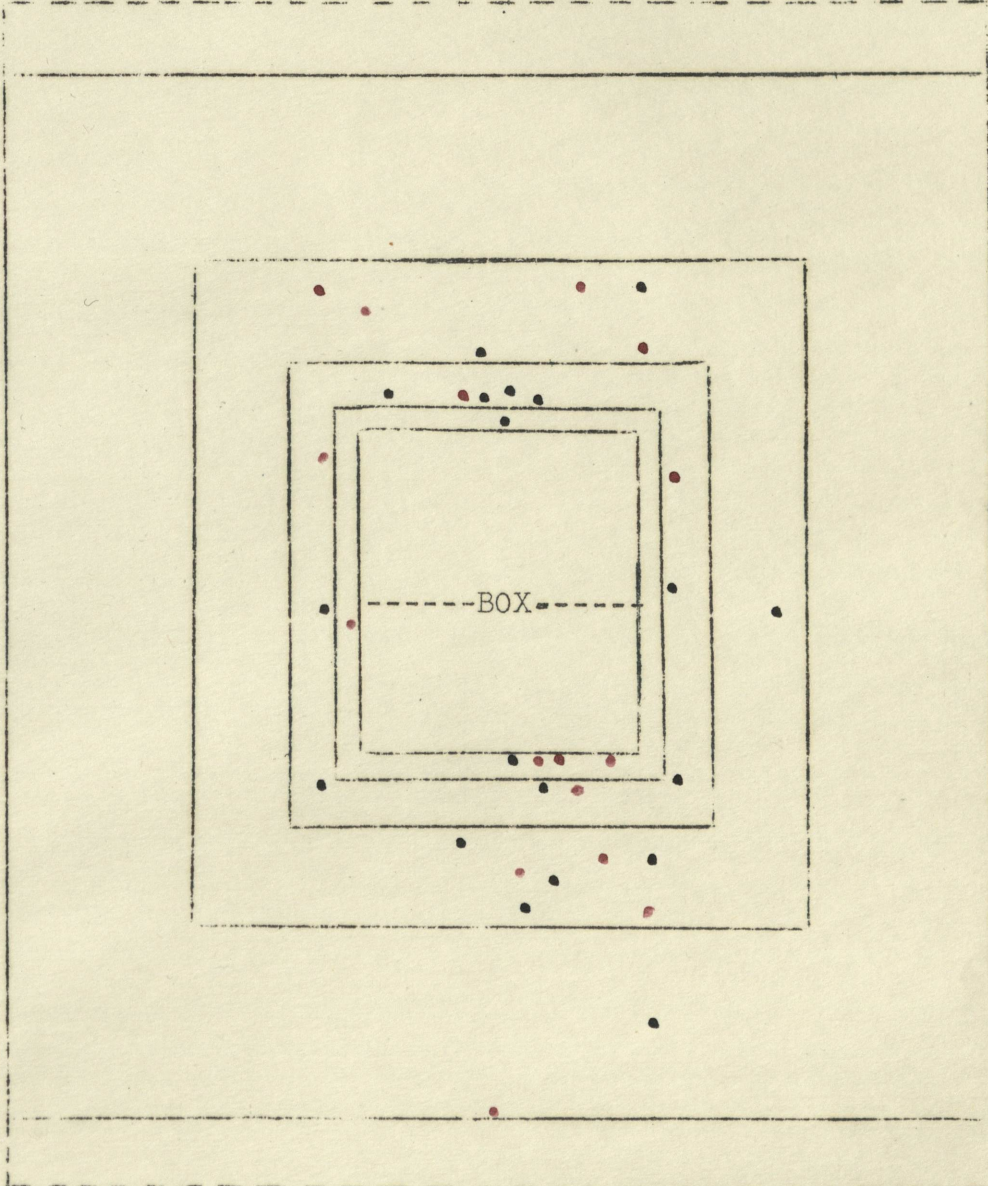


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

W. B. # 12
subject

12 # 64
no. perf. hits



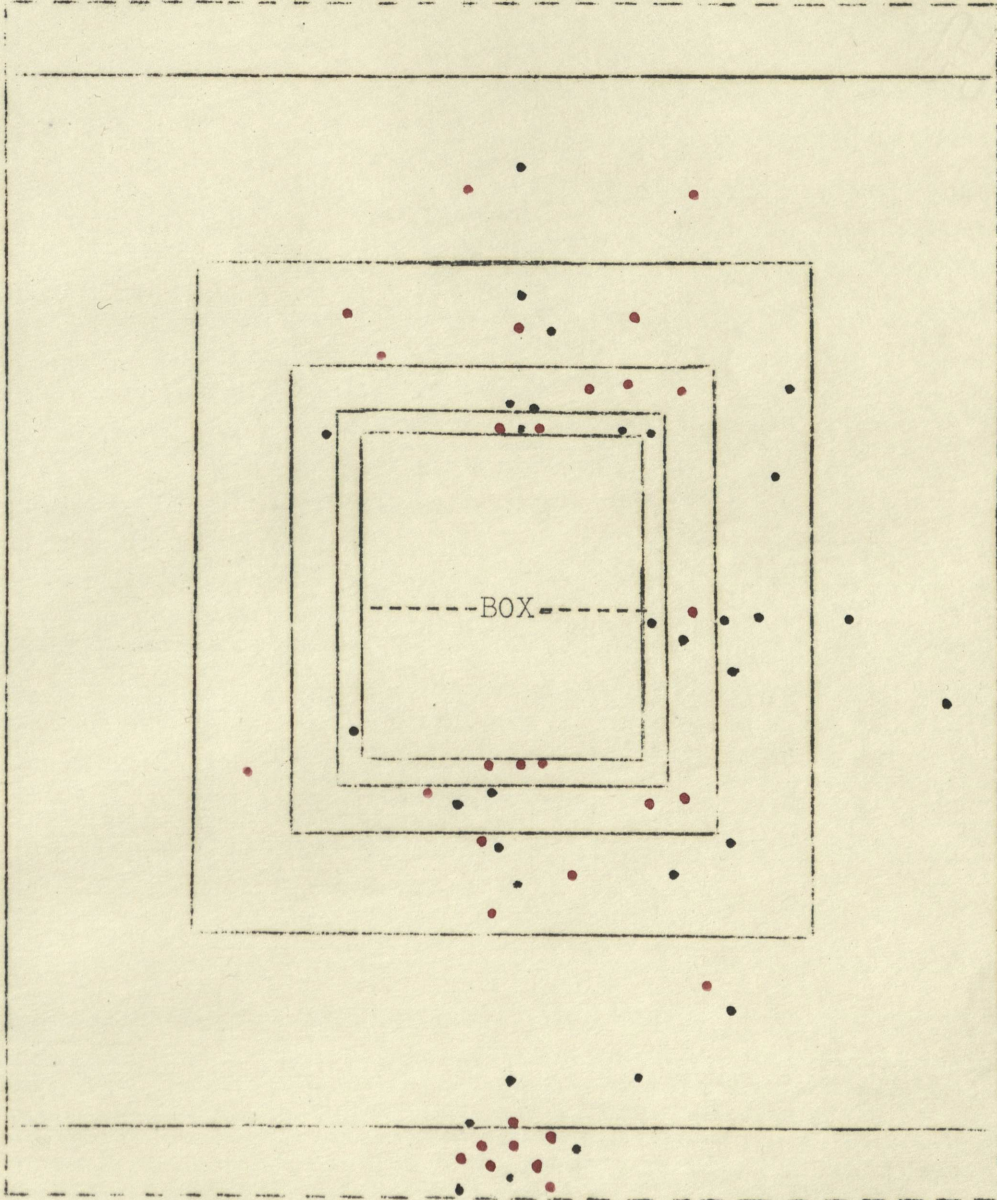
Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

W. B. # 12
subject

1
no. perf.

36
hits

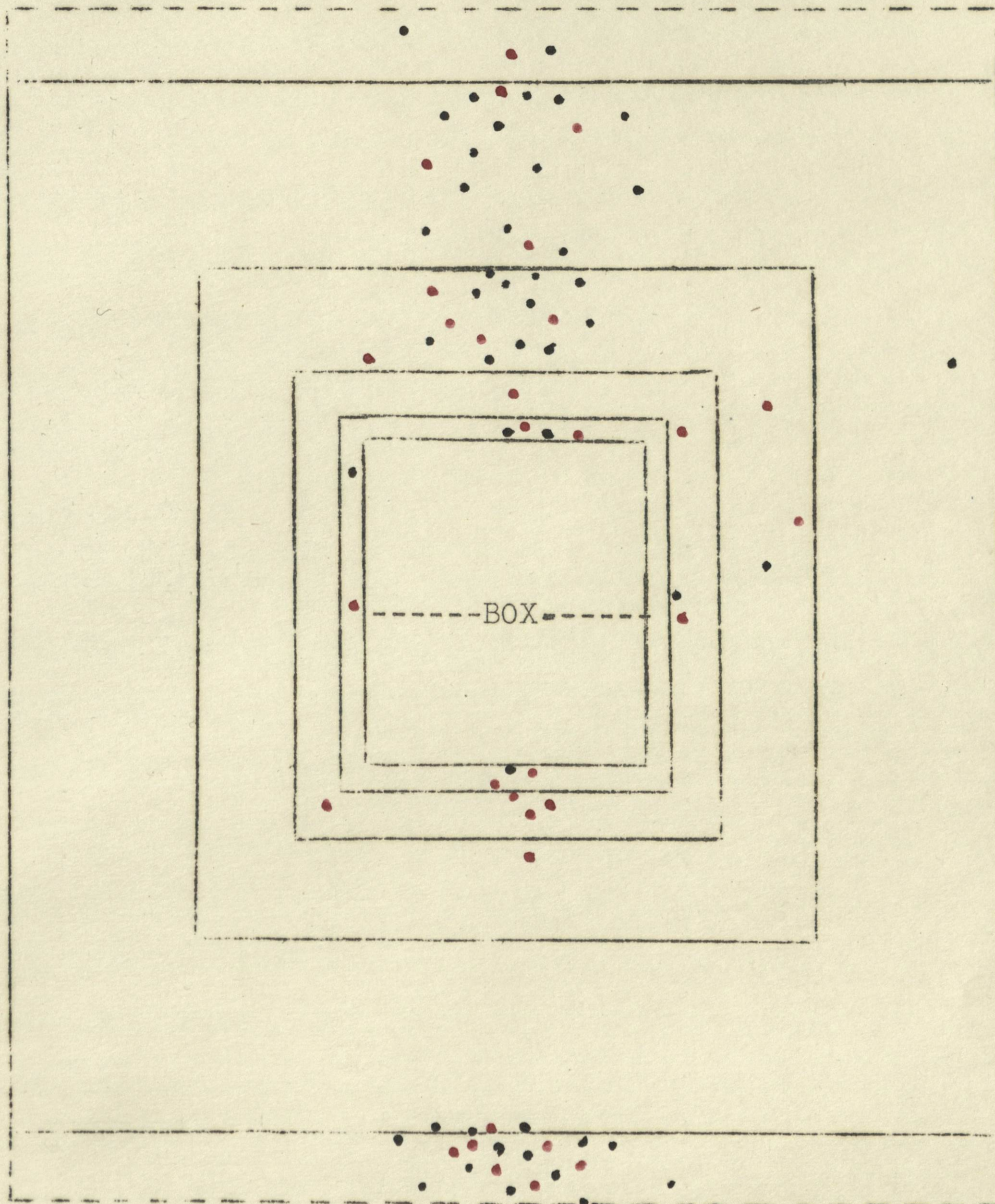


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

A. P. #13
subject

1 # 22
no. perf. hits

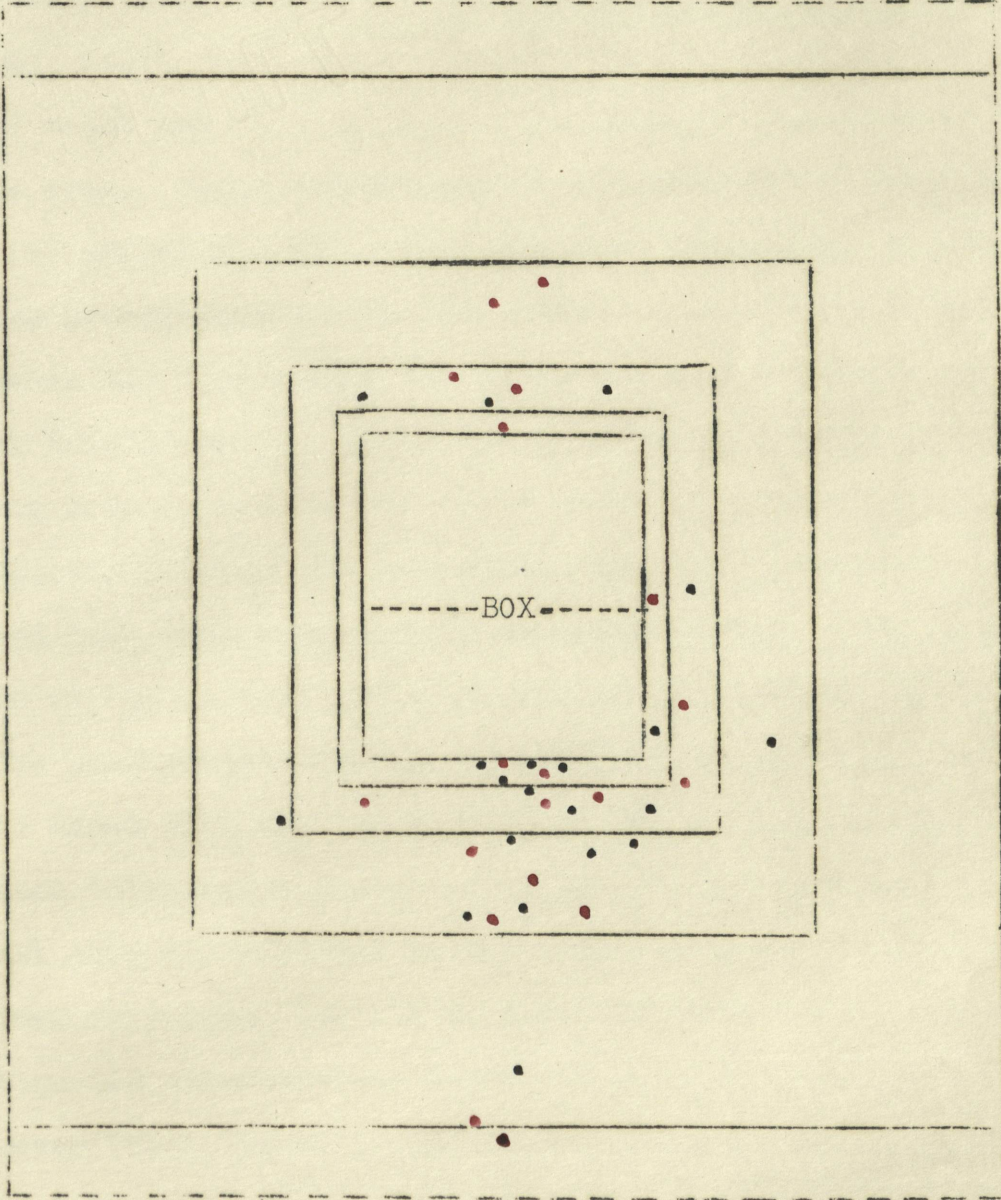


Red dots show dispersion of shots in the first half of performance; black in the second.

SHOT DISPERSION CHART

A. P. # 13
subject

9 # 60
no. perf. hits



Red dots show dispersion of shots in the first half of performance; black in the second.

4. CHANGE OF CONDITIONS

It has already been brought out that an interval of nonpractice after the subject has become skilled in some act does not detract from his proficiency when he returns to it later. Roff found that his subjects after a period of training, could practice at a second farther distance for a number of weeks and then return to the original point and do as well as ever. Their performance at the farther distance in terms of hits scored had of course been less successful. Similarly in the present study a shifting from a nearer to a farther distance and then back to the former caused no break in the general scoring curve. There seemed to be an indication of profiting from such a change of conditions. Moving away from the opening enlarged the perceptual pattern, took more energy, and then upon returning to the nearer there occurred a closing in of the pattern and consequently less energy which now made the performance easier. The group that had been accustomed to shoot from the farther distance and then returned to the same following a number of practices at the nearer distance did not show any material profit from the shift. They did appear more confident, but due to the fact that their perceptual pattern had been narrowed down it took them a little time to recover their former proficiency. Such an explanation does not seem without some foundation if the physiological changes of the organism, and how they are induced, are considered. That some psychological factors were at work in both cases was evident to the observer. The introduction of a change in

conditions added novelty, created more intense interest, revived proper attitudes, and presented a new goal or stimulus arrangement to be attacked with renewed effort and determination.

5. TRANSPOSITION

Much ado has been made about the problem of so-called transfer of training. The old long-accepted notions of transfer have been pretty well shaken by contemporary investigators. No one denies however that people do profit by past experiences, it is only that the theory of specificity of transfer does not warrant acceptance. In motor learning experiments it has been definitely proved that there is what is called cross transfer as well as bilateral transfer. The investigations of Ewert, Bray, Downey and Anderson, and others, all support this contention. Roff also, in his golf shooting experiment, found positive evidence of the transfer with a change of conditions.

In this study it became a special point of interest to study the matter further. It may be said at the beginning that what has been called transfer was very much in evidence in the present experiment, not only of effect but of complete methods. With a change of conditions the stimulus arrangement as a whole is different. In this particular study it was either an expansion or contraction of a relatively constant pattern. Three subjects started their training at a distance of $13\frac{1}{2}$ feet from the lower edge of the opening, and three started at a distance of 9 feet, the areas and the dimensions of the openings were relatively the same from each distance. After some weeks of practice the conditions for the two groups were reversed. A number of practices followed under the changed conditions and then the subjects

were shifted back to their respective starting distances for a final week. The table (below) shows the results of transfer and at the same time what happened with a change of conditions.

The first three subjects changed from long distance $13\frac{1}{2}$ feet, to short 9 feet, and back to original; the second three from short to long and back to short or original.

The results represent weekly averages.

...Subjects..	week before..	first week..	second week..	back to..
	change	of change	of change	original
# 8, R.B.	53	64	65	41
# 9, M.M.	37	51	45	35
#10, N.R.	42	49	47	44
#11, D.S.F.	40	31	25	42
#12, W.B.	60	33	30	52
#13, A.P.	56	36	42	52

Figuring on the basis of the total number of hits scored by each group at the end of a certain performance, the progress of the three shooting from the nearer distance had been more rapid, and it also indicates that their problem was the easier, granting that the abilities of the ~~these~~ three ^{was} not superior. When the three that had started at the farther distance were brought in to the 9 feet distance each went to a new high peak the first time forward, #8, R.B., increased his by seven points, #9, M.M. by one, and #10, N.R. by eight. The three moved back to the $13\frac{1}{2}$ feet point in every

instance fell below their average performance attained at 9 feet, #11, D.F.S. by five points, #12, W.B. by twenty-two, and #13, A.P. by eleven. It is a surprising thing to note that the sum of hits scored by the three brought forward during their initial performance is greater than the sum obtained when the best scores of each of the forward group are added, the sums stand 179 against 176. If averages are taken over a series of performances the same thing still holds, the differences are more striking. The preceding table illustrates this to some extent.

In short, the group shooting from the farther distance had gained more insight relative to the coordination required for the nearer, while they were practicing at the farther distance, than had the group practicing at the nearer over a long period. Experience obtained at the farther distance encompassed the necessary requirements at the shorter distance. There is also evidence of transfer of the part of the subjects who moved from the 9 to the $13\frac{1}{2}$ feet distance, although less outstanding. #8, D.F.S. made a better score on his initial performance than he had the period previous while shooting from regular or short, the latter was not one of his better scores however.

It appears that in a problem of this nature when a subject is shifted from one task to another that theoretically is not more complex, but psychologically is, that there is less likelihood of an equal amount of transfer. Individual differences are admitted and recognized, however they were not great enough to falsify the preceding statements. In

sum one may feel with reasonable certainty that insight into a problem is not sufficient for its proper solution when it presents a stimulus arrangement that takes more energy than the organism has been expending. Before a sufficiently adequate response to an enlarged stimulus pattern is possible the organism must mature to a corresponding degree, which takes time.

Roff was of the opinion that in the case of direct transfer the score under the new conditions, distance $\frac{1}{2}$ greater, should reasonably be expected to approximate $\frac{2}{3}$ of the score made under the original, 9 feet distance. The present writer is at a loss to understand how he could justify any prediction of the sort, since so many new factors enter in when the subject is moved back. The perceptual pattern is enlarged and in addition the farther distance permits of an entirely different sort of shot. It isn't merely having to put more force into the stroke or of hitting the ball so much harder.

It is interesting to note however, that Roff's $\frac{2}{3}$ estimate as being indicative of direct transfer is not far off the mark established by the two groups in the present study when they were shifted from one distance to another, either fifty per cent farther away or that much nearer. It must be remembered of course, that in the present experiment the openings were kept proportionately the same for both distances. It appears to the experimenter that it is ^{not} quite indicative of direct transfer under either Roff's conditions

or the present. At neither time were all the possible variables kept proportionately constant or under control. As yet no psycho-physical formula has been invented or standardized by means of which ^{any} fairly accurate estimate could be made of the necessary amount of variation that should follow at varying distances in order to be indicative of direct transfer.

6. WARMING UP

A factor that apparently facilitates the rapid conditioning and the formation of motor patterns is the so-called 'warming up' process. The term as used by psychologists seems to connote something different from the common usage, it needs to, if it is used. Different experimenters in studying motor learning have been assured and have emphasized the fact, that a warming up period is essential and conducive to expert or the best performance. The quantitative data in the present study reveals that in general more hits were scored in the latter half of performance, 11 out of the 13 subjects show improvement, two, #9 and #12 did equally well in both. Warming up as such scarcely explains the difference however, unless the term is broad enough to cover a multitude of things. The opening of a practice presents a different picture than does the close, and what's more, the reactions of the subject change as the end approaches. If a skilled subject started his practice with the same intentness and care that he exhibits toward the end the difference at any time would be slight. If warming up is so essential how are we to account for the fact that skilled people can go through a complex performance without such a preliminary period. The reason that a performer becomes more proficient after he has taken a number of trials is due then to the relearning that is going on, the pattern is becoming more highly structured.

Not infrequently during the present experiment some of the subjects would take what they called a few warming up

strokes. It was observed, after some proficiency had been attained, that as often as not these preliminary shots were good, often a greater percentage than after a count was kept. The difference between the performance of the first and second half is due to the accentuation of the pattern or to the use of more energy, manifested in both the additional effort put forth and the change of attitude. In short, ordinarily the subjects tried harder toward the close than at the beginning. Overtrying does not do any good, nevertheless a certain minimum of effort is necessary.

7. INDIVIDUAL DIFFERENCES.

In learning a complex problem of the type presented in this study, the general reactions of the subject to the situation are of interest. Individual differences were ~~not~~ at once apparent. No two of the subjects even as much as took the same stance, and varied still more in the finer movements. The subjects, as explained earlier, were not instructed as to stance, stroke, or method. Each developed his or her own technique, somewhat patterned after a standard perhaps but none the less individual. It appeared that methods were discovered and improved upon without conscious intent in some cases. With the exception of one or two of the more or less experienced none had what might be called a set form, and the least experienced never really did acquire a set stance and swing. Some were constantly modifying their tactics or trying something new in the way of grip, use of wrists, extent of follow-through, length of back-swing, spacing of shots, use of one or more than one ball, spotting of ball, moving or not moving form position during performance, putting forth great effort or scarcely any, and possibly many other things not observed.

In their explanation of the factors believed pertinent to the solution of the problem different points were stressed. All agreed that a certain amount of muscle tonus was essential but beyond a variable maximum tenseness it lessened efficiency. The factor of relaxation was also emphasized by all, as the introspections reveal. Some felt that progress lay in the

reduction of variables relating to stance and general technique, elimination of unfruitful ones coming with experience.

In regard to the things that influenced them one way or another the subjects held decidedly different opinions. What was annoying to one, as for example the return of the ball down the runway, another would not be disturbed by it in the least. In every case the return of the ball was a part of the total pattern, less significant to some than to others. As the experiment continued the individual difference showed up even more strikingly. There was a noticeable shifting in the importance of details that went to make up the total situation, indicative of changes taking place in the perceptual pattern, not equally rapid and extensive in all subjects to be sure.

The ease or difficulty with which a subject could get started and keep going varied considerably and influenced later results. In general the more analytical were not as much affected by the results whatever they happened to be. The more highly sensitive subjects, following continued failure or interruption, became too tense, and not infrequently were unable to regain ordinary stability,

What has preceded suggests that certain qualitative factors are of special importance in the acquisition of skill in a complex motor performance. Those to be mentioned and briefly discussed were observed to be significant, however it is not to be assumed that the list is exhausted.

8. PHYSICAL CONDITION AND SUBJECTIVE STATES.

An observation that has been made by practically all experimenters using human subjects is that physiological changes markedly influence individual reactions. Swift(31), Bray (4), and Roff (26), make it a special point of emphasis. Illness, injury to some limb, nerve, or muscle, nervousness possibly brought on by excitement or extreme fatigue, emotional disturbance, more particularly a form of stage fright, have all been observed to impair proficiency in motor learning. In the present study of factors enumerated above were noted to be the primary causes of lack of efficiency. Almost invariably if the performance was undertaken or continued while any of the above conditions existed there was a great impairment of ability. The point is well illustrated by following observations. #13, A.P. fell off considerably after a lapse due to illness and his shooting suffered whenever a strain developed in his back. This latter observation applies to most of the subjects, loss of pattern with growing strain or stiffness. Colds also proved distracting and lowered the efficiency of the subjects, #11, D.T.S. is a special case. #10, N.R. was very erratic during the wrestling season, in part due to minor injuries. Immediately with the close of active participation his curve rises consistently. #8, R.B. was handicapped by a lame wrist, #5, B.S. by a sore arm. Nervousness induced by the presence of spectators caused some of the subjects to do badly.

Not alone the unusual physiological changes determine the nature of a reaction, it is also known that normal metabolic and glandular changes constantly going on in the

the body influence the responses made in any given situation. It has been observed that these normal physiological changes, appearing periodically as they do, both account for and explain the various characteristic rhythms appearing in connection with continuous work curves. The series distribution of shots, discussed earlier, shows periodicity, and are not under the voluntary control of the subject. The reasonable explanation seems to be that muscular coordinations and mental states are modified concurrently with periodic physiological changes.

Mere subjective states, as Swift(31) and also Roff(26) indicated, were found in this experiment to be a false index of the subject's probable performance. As like as not a subject would turn in a high score complaining about not being in the right mood. Such inconsistencies can in part be attributed to the frequent change of attitude and interest. The relative effects of a good or bad start, and of good or bad shots or series during the performance, influence the final result. It must be said however, that a confident approach, a positive assurance of being able to hit the target, often appeared to be a favorable contributing factor to success. #8, R.B. reached a new high score on February 25, he felt assured at the start he could improve. On March 9th he did very badly even though he was in a very fine mood. Predicting a bad score on his 15th practice he nevertheless did very well. #9, M.M. started his fourth practice with confidence, did very well until he became overconfident. #13, A.P. predicted a low score on March 24, felt tired, he reached a new high mark. The few observations selected at random are typical of many, they tend to con-

firm what was said above that self-assurance apparently contributes to success while mere moods are not reliable index to probable results.

9. EFFORT AND PERFORMANCE.

It was very early observed that the application of strenuous effort is only effective to a certain point, the amount expended voluntarily does not correlate with accomplishment. Effort unless sustained by additional motives and the necessary and proper conditions does not lead to fine motor coordinations. Roff (26) and Tukayas (36) in their studies commented on the fact that progress made is not in keeping with effort expended. Their conclusions are strikingly borne out in the present experiment. The introspective data reveal the truth of this many times.

On March 9th #8, R.B., shot a very low score although he had tried with extra effort to do well. #9, M.M. experienced the same thing on March 30th, strenuous effort did not lead to a good score. #11, D.F.S. during his 18th performance under desperate efforts scored only once out of 25 attempts. #12, W.B., made very rapid progress at the shorter distance but when shifted to the longer his best efforts resulted only in a very mediocre score. The experience was common to all; whenever the pattern was unstable strenuous efforts could not establish it. These unique experiences invalidate the old trace theory, they are apparently the resultants of inadequate neuro-muscular organization.

10. ATTITUDE AND PERFORMANCE.

Much has been written with reference to attitude as a factor when of the right sort, as a possible aid to learning. Numerous studies and observations have been made in an attempt to measure the influence of attitude or intention. One of the earliest experiments that had for its aim the comparison of units of work done under two different attitudes was carried on by Wright (40). He found that under an incentive a subject not only accomplished more, but also became less fatigued. Bronner (6) finds the results of mental tests greatly influenced by mental attitudes. The influence of attitudes to amount of output in practical situations has been studied and found to correlate with laboratory results.(18)

The conclusions reached by Freeman(12) and Sanderson(27) in their recent works on the influence of intention and attitude are, in substance, in accord with those of an earlier period. Sanderson found, in studying the effect of motor learning, after instilling in the subjects a specific mental set, that intention is an essential factor to learning. Freeman, by the use of association problem, found that aimless repetition was of no consequence and concludes that an attitude of insight is more important in learning complex material. What has been found true by the various people mentioned was very much in evidence in the present study. In case interest was lacking, whenever the attitude was one

of going through so many motions, of getting the thing done, the performance was so much time wasted as far as learning and improvement were concerned.

11. EFFECT OF AUDIENCE UPON PERFORMANCE.

It is common knowledge that individuals are often unable to perform well under critical supervision or under the eyes of an inquisitive audience. Laird(22) studied the changes in motor control and individual variations of subjects when working under the observation of both a friendly and a silent audience and when performing under a noisy and disparaging audience. Great individual differences appeared, although in all subjects steadiness and coordination diminished. Gates(13) in an attempt to get a quantitative measure of the effects of an audience upon the coordination of motor processes of a group of subjects found that the mere presence or absence of spectators had little effect, except in possibly a highly superior or sensitive individual. Allport(1) is convinced of this latter contention after reanalyzing Gate's data.

The subjects used in this experiment with perhaps one or two exceptions disliked to shoot while spectators were present. It did seem to make a difference who the spectators were, there apparently was less objection to being observed by those taking part in the experiment, although a few at the beginning evinced, what appeared to the experimenter, a form of stage flight without an audience. Comments made at different times by the subjects, substantiated by their reactions, was confirming evidence that they found it more difficult to make fine coordinations with an audience present.

INTERPRETATION

The learning process insofar as it appeared to the experimenter, supplemented by quantitative and introspective data, could in no way be said to have been the outgrowth of early random performances mechanized by repetition. The process from beginning to end showed signs of organization, although the initial trials were as a whole less markedly integrated responses. Without some organization it is scarcely conceivable that an organism could respond to a situation, let alone establish a correct response which is of necessity complex. Although the subjects tried very hard in the beginning, perceived their goal, their efforts were in the main ineffective. The wide scatter of shots and the infrequent hits, clearly shown by the tables, charts, and curves, indicate the lack of adequate and sufficient organization.

With practice came freedom of action and, also greater concentration of results, which in part may be attributed to a truer alignment of musculature involved. With increased proficiency the subject needed less to adhere to a rigid routine, signifying the development of a general pattern of action. This becomes more evident when it is remembered that the subjects could respond ably under altered conditions. The point has been made, supported by the ^eresults, that improvement and stability in motor performance cannot be willed. The exact coordinations come with practice and maturation. The fact that they are not subject to voluntary control and are greatly influenced by physiological changes leads to the conclu-

sion that action patterns are the resultants of neuro-muscular organization.

The correct solution, as has been suggested, involved more than mere insight. This is also shown by the fact that some of the new subjects, who possessed considerable golf technique and had practical experience, were unable at the outset to react to the problem as efficiently as the less proficient of the relearning group. Rational judgement while very essential is of little avail until neuro-muscular organization, made possible by stimulation and maturation, has had opportunity to develop. Skill in a motor performance does not come without practice, however it is to be noted that the proper alignment of energy often appeared to be a rather sudden process once the situation was clearly perceived. This apparent suddenness of perceiving new relations and the knowing how to do without being able immediately to execute correctly, are indicative, according to Coghill(7), that there is a man 'forward reference' in neural mechanism as well as in behavior.

Coghill was led to the above conclusion following a very careful study of the *Ablystoma* and the findings of comparative embryological studies. Thorough analyses convinced him that the order of development of the conditioning system is from centre to the sense organs. He also discovered in the *Ablystoma*, what embryologists have found true to a greater degree in humans, that there exist in the association and motor systems an overgrowth of neural mechanisms beyond the capacity of the organism to express their full nervous poten-

ial in behavior.

Coghill(7, pp.93) says, "This overgrowth of the conditioning mechanism cannot intrinsically anticipate the particular remote situations; but it must represent potentialities of behavior that can come to full expression only in the future. This is not to say that the mechanism in question has no function in earlier periods. . But it certainly means that there is a mechanistic equivalent for man's ability to develop attitudes that can come to expression only in future behavior."

Coghill's observations and suggestions as applied to human behavior offer an advanced and reasonable explanation of certain features of learning that have baffled scientists, and they appear to account in a unique way for certain steps in motor learning that cannot readily be explained otherwise. In this particular problem, as Roff also was convinced, the behavior observed was a case of "forward reference", in that the subjects, as their own comments verify, perceived the goal, knew what they were required to do, but found their best efforts unavailing until their neuro-muscular mechanism had been adequately conditioned by repeated stimulation and subsequent maturation. The energization of the perceptual pattern cannot fall below a certain minimum if the response to the situation is to be sustained and continue in rhythmic order. A number of factors, all a part of the whole situation contribute to the acquisition of skill, the lack of one leads to loss of balance and the performance suffers.

That a state of well being is important in sustaining

and hastening the structurization of motor patterns has been emphasized. Lack and dissipation of energy resulted in less finely coordinated responses, and voluntary efforts on the part of the subject to improve coordination at such a time are futile and often lead to further disintegration of pattern. While most of the subjects confess a recognition of the correct pattern when present, their moods as such are a very poor indication of its stability.

In conclusion it may be restated that the principles of the trial and error hypothesis as applied to human motor learning are inadequate and unjustified. As far as the results of this experiment are concerned. It is true that the initial attempts are crude compared to those that follow with repeated stimulation and growth, yet in every stage of the learning process the response is the whole being acting to the total situation as it is perceived at that time.

CONCLUSIONS

A. From Quantitative Data.

1. The evidence appears quite conclusive that the motor patterns developed under the conditions of this experiment are relatively permanent.
2. The quantitative data reveal that improvement was rapid during relearning as long as interest was sustained.
3. Successful trials appear in groups and the group series tends to lengthen with increase of proficiency. There seems to be a rhythmic periodicity in the frequency of appearance of series.
4. There is a rough positive correlation between length of successful series and total daily score but the most proficient subjects do not consistently get the longest series.
5. With the increase of skill there is a general improvement in accuracy, the gross errors become less frequent.
6. Subjects trained at the shorter distance could return to it, following a few weeks practice at a farther distance, and suffer no impairment of proficiency.
7. Subjects trained at the farther distance and upon subsequent return to the same, following a few weeks practice at a shorter distance, did not immediately recover their usual proficiency. The indications are that with a return to an enlarged stimulus pattern a little more time is needed to recover previous coordinations.
8. Transfer was more evident in the case of subjects brought forward, that is, with the contraction of stimulus pattern.
9. In general a greater percentage of successful trials is made in the latter part or second half of a practice period. Evidence for the necessity of 'warming up' becomes less pronounced with the differentiation of pattern.
10. Learning of a complex motor problem such as presented in this experiment does not proceed gradually, sharp rises are common.

B. From Qualitative Data.

11. Methods are hit upon and improved without conscious intent.
12. Learning goes on in spite of, rather than because of, recency and frequency.

13. Physical well being is essential to the best performance; deenergizing physiological changes disrupt highly coordinated patterns materially. Moods are very unreliable as indicative of pattern stability.
14. A variety of extraneous factors such as the presence of spectators, noises, talking, rebound of ball, affect motor instability or give rise to 'irradiation patterns.'
15. A certain minimum of effort is essential to progress, though the maximum is a variable standard. There is no correlation between excess effort expended and success. The act cannot profitably be made too obtrusive.
16. Periodic physiological changes may govern the fluctuations observed in motor performance.
17. Improvement seems to be due in part to the maturation of the organism not only during the time of practice but continues after the practicing period.
18. The construction of an action pattern requires some time, a 'period of initial delay' preceding the execution seemingly is effective to more rhythmical coordinations.
19. More than mere insight is needed to become proficient in motor performances, adequate neuro-muscular organization is necessary.
20. It is reasonably evident that the whole being is concerned in every response and that maturation is the basic phenomenon in the development of motor configurations.

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