

DISTRIBUTION OF PRACTICE PERIODS IN LEARNING

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Those engaged in the administration of education feel a need of more knowledge in regard to the matter of distributing the learning periods. Much time is given to the arrangement of the program of studies in regard to the subject matter, but not so much attention is given to the more important question of how to arrange a program that will be most profitable to the learner.

PROBLEM STATED

How shall the periods of learning be so distributed as to give the most economical result? This problem is of especial interest to educational psychologists who have made experiments in both animal and human psychology in an effort to solve it.

PREVIOUS EXPERIMENTS

In regard to periods of work up to a limit of twenty or thirty minutes, the conclusion has been reached that one practice period per day gives better results than any other larger number per day. Lashley found in archery practice that the group which made five shots per day showed greater improvement for the same number of shots than those who made twenty shots or forty shots per day.

As yet, no conclusion has been reached in regard to the value of alternate days' practice compared with daily practice. Pyle, from his experiments in transcribing reading matter into new characters, concluded that daily practice is better than practice on alternate days. He had, however, only six subjects in the test, and, even to this conclusion, he adds that after the initial stages alternate days may be better.

Professor Leuba and Miss Hyde of Bryn Mawr have added some information to this question in their tests on "Hand Movements." Their test was to find out the progress in skill in writing English prose in German script. Four divisions were made of their subjects: One group working twice per day, one daily, one

on alternate days, and another every third day. From the chart on page 41 will be seen in the progress, as noted, very little difference between the alternate and daily practice groups, but in comparing them with other groups a decided showing is found in favor of the daily and alternate-day groups. One defect in this comparison is the short length of the curve. The indications are that with further practice the alternate group would compare yet more favorably. The table below shows that at the end of the tenth trial the group working on alternate days was superior.

Twice per day 865 (Words)	Once per day 1115	Alternate days 1175	Every third day 985
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TECHNIQUE OF EXPERIMENT

The following experiments were devised to test the relative merits of daily and alternate day's practice in such muscular activity as javelin throwing. Although such was the chief function of the experiment, yet other practice periods were given to different groups. There were twice per day and once per week groups. Some data will be shown as the result of the latter. The most careful study was given to the five-times-per-week, the three-times-per-week, and the once-per-week groups.

The experiment was performed with normal school girls from the senior and junior classes. Three groups of ten girls each from the senior class were formed for the five times, the three times, and the once per week-work, respectively, and two groups of seven each from the junior class. One group threw five times per week *daily* and the other twice per day, the latter making five throws in the morning at 8:45 and five in the afternoon at 3:00.

I shall designate the group that threw five times per week from Monday to Friday as Group I; the group that threw three times per week, Monday, Wednesday, and Friday, as Group II; the group that threw once per week on Thursday as Group III.

APPARATUS AND METHOD OF EXPERIMENT

The following description will explain the arrangement of material used in the experiment. A soft pine board about 70 cm. square was firmly fastened to the wall of a classroom. In the center of the board a small spot 1 cm. in diameter was painted. This was the target and was put at the height of 150 cm. from the floor. Twelve feet from the target a chalk line was drawn on

the floor. When the subject made the throw she placed her toe on this line. The javelin was handed to the thrower and she was told to hit the target, throwing with the left hand. After each throw an assistant handed the javelin to the performer so that her position was not changed. No other directions were given nor was any comment to be made upon the result of any throw. Only the persons helping in the experiment were in the room and generally only one subject came to the room at a time.

SELECTION OF GROUPS

The thirty students in the senior class were given a trial throw on Monday, Nov. 9, at 1 P. M. Each person was asked to throw five times with her left arm. If she was accustomed to using her left arm for throwing, she was excused from the experiment. The distance was found to be of such length as to require some effort, and yet was not beyond the strength of any of the performers, with, perhaps, one exception. After the thirty girls had thrown five times, the average of the five throws was taken as a measure of possible ability and groups were then formed so as to have ten in each whose ability would be about equal. The following are the figures showing the relative abilities as evidenced in the following test throwing:

<i>Average in Centimeters of Ten Girls for Five Throws</i>		
Group I	Group II	Group III
86	85.2	85.5

No attempt was made at introspection while the students were throwing, but the difficulty experienced in performing the task was plainly evident. The erratic throwing and the new situation aroused an emotional attitude in most of the girls and called forth such expressions as "I'll never do it," "I never could do anything with my left hand," etc. Such conditions persuaded us that we were attempting to form a pattern in the nervous system whose elements had very little past association. It seemed that here was some virgin soil upon which might be grown habits whose growth, if carefully noted, would yield some evidence of the conditions which would be most favorable for improvement.

Some one interested in formation of habits which pertain to schoolroom work may ask, "What can you carry over from such an experiment that will throw any light on solving problems of

learning in school?" Learning is making connections in the nervous system. These connections are supposed to be formed by the impulse breaking over or through the synapse. What difference can there be in forming this connection in the neurones controlling the movement of the arm and those controlling the cortical set that responds with a rule in grammar or any word response? Thorndike says that the same law of behavior in the neurones will be found to account for the effects in both typewriting and the learning of nonsense series. There are connections lacking in both places. Of course phylogeny may explain to us that neural bonds which are made in such movements of hand and arm are older in the race's history and therefore easier to form anew than the so-called higher connection; but who can prove that the same methods of improvement will not avail for all neurones? Many school habits of motor type are very similar to habits formed in this experiment and it will not be useless for the pedagogue to consider such lessons as the experiments in skill may have to give. The great objection to the so-called mental tests (as Dr. Watson states) is to be found in the fact that the complexity of the word habits makes it difficult to have any assurance that many past associations are not entering into the supposedly new arc formation.

We state these reasons not as an excuse for our experiments but as an explanation of why we consider such work a good source from whence pedagogy may derive some help. The more isolated the arc formation the more easily conditions can be controlled.

PROCEDURE OF EXPERIMENT

Winch states that one ought to have an experiment planned so that whatever bias the experimenter has may have the harder part of the problem. If there was any bias in the mind of the experimenter it was in favor of daily practice, but the conditions were absolutely the same for all the groups, and a careful daily watch was kept on any point or outside influence that would affect the results. At 2:30 P. M. on Wednesday, Nov. 11, Group I began their throwing and threw on each succeeding school day until they had had thirty-four practice periods. At 1:00 P. M. on Wednesday, Nov. 11, Group II made their first throw in the experiment and continued to throw every Monday, Wednesday, and Friday, until their practice periods numbered thirty-four. On Thursday, Nov. 12, at 1:00 P. M.

Group III commenced their practice of once per week. They have not had an opportunity to have as many practice periods as the other two groups, but their progress is noted in comparison with the other two groups in Fig. 1. This graph is made from the total of daily averages for each group.

It will be seen that the initial improvement was somewhat more marked in Group I than in Group II; but from the middle of the practice periods the improvement of Group II is very much faster than that of Group I. At the end of the twenty-third practice period for Group I came two weeks intermission for the Christmas Holidays, and you will notice a perceptible rise in the curve at that point. This point is marked on all the curves by an X. Not so marked, however, is the rise of Group II showing that the lapse of time made very little perceptible difference. It should be noted that in Group II one of the girls was very slow in learning; in fact, from a glance at her score in Table V it will be seen that there was little improvement. Her high score was handicap to her group whose progress would have been still more marked in comparison with Group I. (By high score we mean far from target and by low score near target.) There were some making high scores in Group I, but none that seemed to have as much difficulty in reaching the board as the subject in Group II. It might have been more exact not to count this subject in the result, as her high score was due to the fact that so many throws fell short of the target, showing lack of strength. This omission would add to the favorable result for Group II.

In Table I you will note the sum of the scores made by Groups I and II. Comparing practice periods at each stage it will be seen that Group II makes a lower score in nineteen periods out of the thirty-four. The result given in the table shows the progress that was evident to the observer. Those in Group II (with one exception) appeared more confident and handled the javelin with more ease and accuracy, as will be shown from the median and the standard deviation in Table VI.

The dotted line on the graph shows the progress of Group III. Although the test practice gave evidence that Group III was equal to the other groups, yet on beginning practice this group made the best score. On the fourth and fifth practice they made a higher score than Groups I or II, but from the fifth practice there was rapid improvement to the thirteenth, when a lower score than either of the other groups was reached. In fact the

TABLE I.

Average for Two Groups

Group I Ave.	Group II Ave.	Group I Ave.	Group II Ave.	Group I Ave.	Group II Ave.
*80.01	82.24	57.25	62.92	56.16	46.96
67.41	72.90	53.35	63.18	51.49	46.48
75.42	76.61	54.66	53.42	58.17	46.96
70.33	76.41	66.25	64.14	47.80	51.77
68.60	68.19	57.59	63.06		
74.33	65.30	52.95	60.49		
71.95	57.91	57.79	59.49		
71.42	63.50	58.14	55.47		
75.97	61.66	66.16	48.72		
74.57	68.42	58.57	46.53		
73.43	74.77	68.81	43.93		
57.35	59.17	57.58	47.89		
50.81	60.91	55.64	42.39		
57.48	70.51	70.78	40.58		
53.22	67.76	61.26	50.21		

Daily Average for Each of 9 in Retention Test

Group I	Group II
59.0	50.7
53.6	45.6
55.5	53.0
45.9	46.3

TABLE II.

Trial Practice

Group I		Group III		Group II	
Miss Hu.	38.4	Miss Co.	39.4	Miss So.	45.4
" He.	57.4	" C.	54.9	" Vo.	46.2
" Hei.	59.1	" Hip.	59.5	" Fr.	59.8
" Lau.	69.2	" Ha.	67.4	" Do.	64.2
" Sk.	70.0	" Ho.	72.5	" McK.	79.3
" Jo.	88.9	" B.	84.8	" Har.	79.7
" McC.	88.9	" Lit.	93.2	" Br.	94.6
" Wh.	110.4	" W.	104.8	" St.	103.8
" Du.	120.2	" Col.	129.7	" Ru.	137.6
" Ru.	158.2	" Ma.	149.2	" Jac.	141.9
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	860.7		855.4		852.5

TABLE III.

Median and Standard Deviation Sheet for Five Times per Week Group

	1st 50		2d 50		Last 50	
	Med.	S. D.	Med.	S. D.	Med.	S. D.
Miss H.....	45	32.52	42	25.8	39	23.6
" He.....	105	46.4	63	33.4	40	24.72
" Hei.....	60	38.0	56	24.6	41	23.35
" La.....	50	37.65	35	34.0	57	35.0
" S.....	39	29.34	40	28.6	50	37.3
" J.....	65	45.51	43	23.4	45	28.8
" McC.....	77	36.79	32	33.3	35	25.0
" W.....	63	44.6	65	39.7	53	30.5
" Du.....	120	40.29	78	42.9	75	53.2
" Ru.....	46	42.0	53	35.9	52	38.2
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Av. Total.....	67.0	39.31	50.7	32.16	48.7	31.96

* Average number of centimeters from target.

score at this point was lower than any score made by Group II until the twenty-fourth practice period and lower than any reached by Group I until the very last day or the thirty-fourth practice period.

From this result we do not draw any definite conclusion in regard to the efficacy of distribution for once per week, but the curve does indicate that for such work as was performed in this experiment one period per week gives a good distribution for learning.

ACCURACY OF LEARNING

By looking at the standard deviation and median, Table VI, one will note that there was improvement in both Group I and Group II for average median and for average standard deviation

TABLE IV.
Median and Standard Deviation Table
(once per week)

	1st 50		2d 50	
	Med.	S. D.	Med.	S. D.
Miss Co.....	55	34.7	50	29.4
" C.....	78	48.1	40	28.2
" Hip.....	40	25.9	28	19.0
" Har.....	75	51.4	75	35.0
" Ho.....	63	38.9	45	28.3
" B.....	43	28.7	54	31.5
" L.....	48	21.3	43	22.3
" W.....	110	45.3	55	30.19
" C.....	73	32.5	51	29.6
" M.....	92	55.8	41	33.1
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	677	382.6	482	286.5

TABLE V.
Median and Standard Deviation Sheet
for
Three Times per Week Group

	1st 50		2d 50		Last 50	
	Med.	S. D.	Med.	S. D.	Med.	S. D.
Miss So.....	59	36.4	37	23.5	33	17.2
" V.....	49	27.1	55	28.0	40	18.5
" F.....	61	36.3	54	32.6	46	34.0
" D.....	69	32.5	30	16.3	32	16.3
" McK.....	60	35.8	55	27.0	42	23.5
" H.....	56	42.0	55	31.0	40	31.2
" Br.....	90	45.8	48	51.9	51	36.5
" St.....	61	39.9	62	27.9	31	19.4
" R.....	77	41.3	41	32.5	45	23.0
" Ja.....	122	49.6	158	45.4	75	52.8
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Av. Total.....	70.4	38.67	58.5	31.61	43.5	27.24

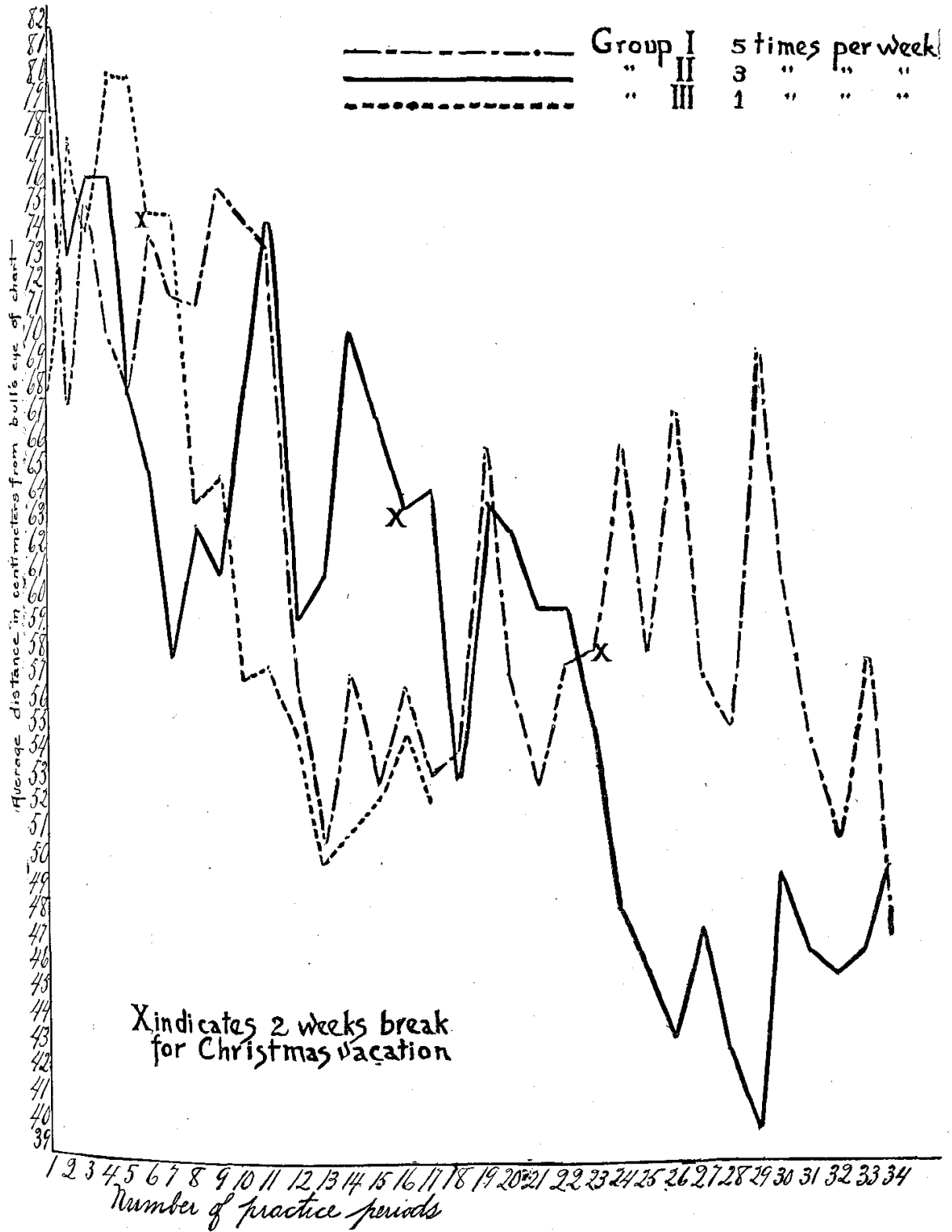


TABLE VI.
*Comparison of Average Median, and Average Standard Deviation
 for
 the Three Groups*

	1st 50		2d 50		Last 50		Retention Test	
	Av. Med.	Av. S. D.	Av. Med.	Av. S. D.	Av. Med.	Av. S. D.	Av. Med.	Av. S. D.
Group I	67.0	39.31	50.7	32.16	48.7	31.96	50.0	32.2
" II	70.4	38.67	58.5	31.61	43.5	27.24	45.0	24.3
" III	67.7	38.26	48.2	28.65				

TABLE VII.
Junior Score

Group I Once per day—10 consecutive shots		Group II Twice per day—5 shots each time	
Total score		Total score	
1. 5926	14. 3915	1. 7077	14. 4336
2. 4881	15. 3850	2. 6024	15. 4347
3. 5381	16. 3747	3. 6765	16. 4343
4. 3973	17. 4284	4. 5518	17. 4480
5. 3415	18. 3965	5. 6537	18. 4416
6. 4500	19. 4107	6. 6169	19. 4359
7. 3954	20. 3706	7. 5392	20. 4121
8. 3647	21. 4230	8. 5113	
9. 3635	22. 3591	9. 4766	
10. 4049	23. 3031	10. 4325	
11. 4331	24. 3714	11. 4029	
12. 4058	25. 3668	12. 4693	
13. 3872		13. 4010	

from the first fifty throws to the middle fifty and from the middle fifty to the last fifty throws. In both the median and deviation averages Group II led Group I, showing not only that the score was lower but that greater accuracy had been obtained by this group. The middle fifty group was composed of the fifteenth, sixteenth, seventeenth, eighteenth, and nineteenth practice periods. These periods for Group I came before the Christmas holidays and for Group II after vacation. Vacation appears to have had a pronounced effect upon Group I but very little effect upon Group II.

The progress of the girls in Group III is very marked both in their total daily average and in their accuracy as shown by the median and standard deviation made from their first fifty throws and from the middle fifty. In the last set of figures they show an improvement over both Group I and Group II. It must also be added that the middle fifty for Group III was composed of the thirteenth, fourteenth, fifteenth, sixteenth, and seventeenth.

practice periods, and that of the other group was composed of the fifteenth, sixteenth, seventeenth, eighteenth, and nineteenth practice periods. A very favorable result is thereby shown in the once per week practice period. From observation of the movements and control shown, we are led to conclude that such a distribution is very effective for learning.

COMPARISON OF TEN CONSECUTIVE SHOTS PER DAY WITH FIVE SHOTS TWICE PER DAY

On Nov. 9, at 2:30 o'clock, a preliminary throw was given to 14 Junior girls. Each one threw five times. A division of the class was made in order to get seven of equal ability. The following totals show how nearly equal their first efforts were:

Group I	Group II
69.7 cm.	69.4 cm.

Group I is the group that shot twice per day at 8:30 A. M. and at 3 P. M. Group II represents those shooting once per day at 2:30. Monday, Nov. 16, Group II began regular practice and continued for twenty consecutive school days. You will note the improvement made from the first to the ninth practice. Notwithstanding the fact that at this point came five days of vacation but a small increase in score was made. There was a month's intermission from Dec. 16 to Jan. 13. Although the first practice after the pause was 4230 compared with 3706 of the last regular practice period, yet the second of the delayed series was 3591 and the third 3031, showing greater improvement after the pause.

Tuesday, Nov. 17, at 8:45, Group I commenced regular practice and threw each consecutive school day. The initial score for this group was higher than for Group II. The improvement, however, was rapid. We did not work out a table of standard deviation for this group but a comparison of daily averages will show that progress was better for those throwing but once per day. Those that threw twice daily had the advantage of a morning hour (8:30) for first trial but very little difference was noted in results from the five throws in the morning and from those in the afternoon at 3 P. M.

RETENTION TEST

Monday, March 22, a retention test was commenced for the two groups, I and II, of senior girls. Ten throws were given daily for five days to each member of the two groups. Owing

TABLE VIII.

Retention Tests

(Given March 22-25, comparing nine in each group)

		1st day	2d day	3d day	4th day
Total Score Group I.....		5310	4830	4996	4131
" " " II.....		4567	4108	4813	4171

	Group II		Group I		
	Med.	S. D.	Med.	S. D.	
Miss S.	33	13.0	Miss Hu.	34	26.0
" F.	57	21.6	" He.	50	34.8
" D.	34	24.3	" Hei.	45	31.0
" Me.	43	27.0	" La.	44	30.1
" H.	39	22.1	" Sk.	60	52.7
" Br.	49	27.0	" Jo.	40	16.0
" St.	35	21.1	" McC.	45	22.4
" R.	34	18.7	" Dn.	65	34.5
" Ja.	85	44.0	" Rn.	68	32.7
	9)409	2)218.9	9)451	9)290.2	
Ave.	45.4	24.3	50.1	32.2	

TABLE IX.

Comparison of Good Shots with Shot Following

Taken from last 50 or middle 50

(Showing 28 out of 50 shots following good shot were above median)

Good Throw	Med.	Next Throw	Good Throw	Med.	Next Throw
11	45	51	7	32	15
1	41	91	8	40	90
1	50	68	8	40	48
4	40	42	10	34	30
10	39	15	10	42	21
3	35	40	4		70
5	35	55	6	46	13
6	52	19	7	32	15
7	40	19	7	40	29
10	39	80	3	37	58
10	45	27	1	46	62
5	50	80	7	41	20
6	53	71	8	41	40
10	53	81	9	55	28
6	39	20	4	37	46
3	45	45	6	42	43
8	40	10	1	37	39
10	42	43	7	41	60
6	43	53	8	30	60
5	78	74	6	48	65
10	42	65	7	55	26
7	63	69	6	30	37
6	42	26	6	62	47
7	32	110	3	30	46
10		49			
9		124			

to the illness of several members, we could not obtain all ten girls for each day's trial, and, therefore, to make the comparison easy and just to both, we have worked out the median and standard deviation for the first four days or for forty throws for each individual, taking nine from each group. The table of these results is given on page 20. The median for Group II was 45.4 and for Group I, 50. The standard deviation for Group II was 24.3 and for Group I, 32.2.

On account of irregular practice at this period the score of one of the best performers in this group is not counted, yet the results indicate better retention for the alternate-day group. The most inefficient worker, Miss J., is counted in that test. The rest period for Group I was, however, longer by three weeks than for Group II. Had it not been necessary to close the experiment it would have been better to postpone this test several months longer.

CONCLUSIONS

From a study of the results in the above experiment, and from a careful study of the attitude of those throwing the javelin, we conclude that learning periods can be distributed by giving alternate days practice, and even weekly practice, without any loss in learning. We believe this to be a conservative statement not only for practice periods involving skill or hand manipulation but also for so-called mental work. We believe we are justified in stating that better work, for the amount of time expended, can be done in our schools through a distribution of three times per week than through a distribution of five times per week.

In the above experiment the curves did not follow the normal curve of learning to any marked degree; but those in the alternate-day group generally gave a better approximation to a regular learning curve. This is especially noted in the curve of Miss D. of Group II. If there is any scientific explanation as to why such a distribution is more economical we may find it in the suggestions of Book that conflicting associations tend to disappear in the periods of rest. We must however give some explanation of the fact that the useless arcs disappear sooner than the useful arcs. Watson gives more prominence to frequency than to any other factor in the learning process, and also lays great emphasis on the fact that thought processes affect the whole musculature of the body. During the rest periods, the subjects, no doubt,

give some thought to the practice in which they are engaged, *but only to the perfect movement they wish to make*. This may serve as suppressed practice for the useful arcs and if the period of rest is of sufficient length a greater handicap is given to the proper *arc* formation.

Surely something like this must explain what the psychologists mean by "attentive repetition's" being necessary for all learning. Learning is a *subtraction* process to a greater extent than an addition process. The Pauline trouble is with all learners in that it is the things we would not do that overcome the useful things. This is illustrated by the table showing the high score made after good throws. It appears that the successful throw turns loose a host of useless arcs which destroy the power of the useful connections. These unwelcome arcs are the cause of much slow learning, and longer periods of rest from those practice periods in which the useless arcs have a part is one way suggested by which we may attain more economical learning.

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