RETENTION AS RELATED TO REPETITION.

WILLIAM H. PYLE,

University of Missouri.

SUMMARY.

Twelve subjects were tested for their rate of learning a passage of easy prose, and for their retention of the passage after a lapse of twenty-four hours. The most rapid learners showed the highest percentage of retention.

In the experiments here reported we have been concerned chiefly in determining the relation of retention to number of repetitions—the relation of memory to quickness of learning. Our results, however, throw light on other problems of memory, and, we hope, have some significance for education.

Much of the experimental work that has been done in memory contributes to the solution of our problem, and, on the whole, points to a positive correlation between learning and remembering (9). Müller and Schumann (4) found that in the learning of nonsense syllables the person that learned a series in the shortest time also relearned the same series after twenty-four hours in the shortest time. The slow learner, however, saved more both absolutely and relatively than the fast learner. But, although the fast learner had forgotten more, he relearned what he had forgotten in less time than was required for the slow learner to relearn what he had forgotten. The fast learner, then, has the advantage; learning, in the first place, in the shortest time, and relearning what is forgotten in the shortest time. Ogden (7) got much the same result. In his experiment rarely does the fast learner require more time for relearning than does the slow learner, and usually requires less. Ogden's experiments include tests with meaningful, as well as nonsense, material, with practically the same results for both. The curve of relearning is, in general, parallel to the

learning curve, although it shows some flattening. The individual differences in relearning are not so great as the original differences in learning. That is to say, the differences in retention of a number of individuals are not so great as their differences in time for complete learning.

Whitehead (11) thinks slow learning means a quicker relearning or better retention, but an examination of his tables (pp. 267 and 268) does not support his contention. If we eliminate the results from one of his subjects (the eleventh in first table, p. 267) as being an error, for it shows a relearning time longer than the time for original learning, and add the relearning times for the fast six and slow six, respectively, we find without exception that the six who had learned in the shortest time also relearned in the shortest time. In fact, if we rank the two series for learning and relearning, for the various tables, from best to poorest, we find a fairly high degree of correlation between quick learning and good retention.

Henderson (2) found that the best learners retained the largest percentage of what they had learned. His experiments did not consist in complete learning. The matter for memorizing was presented to the learners only once, and it was found that those who got the most from this one reading retained the largest proportional amount. This, of course, is not the same as complete learning, for it is conceivable that the slow learner, if he should keep at work till he had learned as much as the fast learner, might retain it better. Henderson's material was much the same as ours, *i. e.*, connected thought. Norsworthy (5) got the same results by using a different material and a somewhat different method. She found that the students who learned the greatest number of words in a German-English vocabulary, in a given time, retained the largest percentage of what had been learned. But here, again, we are not sure of what the results would have been if the slow learners had been allowed to repeat their words till they had learned the same number as had the fast learners. Our experiments give ground to doubt that this would have been the case.

The work of Ogden and others (3) to determine the effects of different rates of presenting material to be learned is not

exactly on the problem which we have before us. Although they found that the fastest rates used in committing nonsense syllables to memory gave quicker learning, but poorer retention than slower rates, it is nevertheless true that of *different* learners using the same rate of saying the syllables over in learning them, the person who memorizes a series in the fewest number of repetitions may retain as well or better than the slower learner.

Our own experiments were begun in February, 1910, and continued for about a year, including the summer session of 1910. Agreeing with Henderson (2) that the kind of memory experiments most needed now is that which deals with thought material, so that the results and conclusions may be applicable to actual school conditions, we selected for use in our work a small book on nature study, entirely unknown to the learners, although its subject-matter made a fairly equal appeal to all of them. The book was divided up into segments, each containing 40 ideas and about 150 words, much after the plan of Shaw (9). Our method was to present the material to the subjects individually in a quiet room under uniform conditions. After each presentation the learner was required to give orally to the experimenter as many of the ideas as could be recalled. The matter would then be presented again, after which the learner would give all the ideas he could recall, and so on till the learner could repeat readily all the 40 ideas. The learning was not required to be verbatim, but in the learner's own words. The learner was also allowed his own time and manner of recall so as to permit each mind to work in its own way. The recall time was fairly constant, however, being five to seven minutes; the quickest learners used the shortest time. Careful records were kept of the condition of the subjects and of all facts that could throw light on the nature of the results. It was found, for example, that poor health, loss of sleep, overwork, etc., always made a longer learning time and poorer retention. In our last experiment the material was always read to the learners by the experimenter. In the first and second experiments the material was presented in three different ways: (1) Reading aloud by the experimenter, (2) reading aloud by the learner, (3) reading

silently by the learner. We finally used only the first method, because it gives a better control of the experiment. If the learner is allowed to read the material himself, one can have no assurance that he does not read portions more than once. Twenty-four hours after each learning the subject was required to write down all the ideas that could be recalled. The subjects were asked not to think of the matter in the interval, and, as a matter of fact, they seldom did.

Our subjects were seniors and graduate students. Four of them were women: B, Ti, J and F. It will be noticed that the women made the best records. Of the twelve subjects, four took part in the experiments shown in Table I, four in those shown in Table II, and the other four in those shown in Table III. In Table I we give not only the average results obtained in the experiments described above, but other data showing the records of the subjects in different kinds of memory tests. Column 1 gives the total number of objects and words retained in a series of immediate memory tests; column 2 the number of repetitions required to commit to memory a series of 25 nonsense syllables; column 3 represents the immediate memory for thought material got at one presentation, while the last two columns show the results for the complete learning of connected thought.

TABLE I.

Subjects.	Words, objects, pictures.	Rep. for nonsense syllables.	Immediate memory.	Av. rep. complete learning.	Retention after 24 hours.
B.....	78	59	22	3⅔	40
M.....	66	134	18	6½	37
Th.....	62	121	10	10⅓	34
Wi.....	49	123	15	6⅓	40

It will be seen that B makes the best record in all the tests. While Wi is poor at everything else, he is good at memorizing and retaining the connected thought. Evidently the memorizing of connected thought involves factors not represented in the memorizing of words or nonsense material. In the later experiments we therefore confined the work to the learning of connected thought.

Table II gives the results obtained from another group of learners. The results are averages obtained from four experi-

ments of each type of presentation, and in the last columns are to be found the general averages and the average deviations expressed in per cent.

TABLE II.

	Read aloud to subject.		Read silently by subject.		Read aloud by subject.		General averages.			
							Av.			Av.
Subjects.	Reps.	Reten.	Reps.	Reten.	Reps.	Reten.	Reps.	dev.	Reten.	dev.
Tr.....	10.5	35.75	6.5	35.75	5.5	30.25	7.5	28%	33.92	7%
St.....	4.75	35.00	4.0	35.25	4.5	31.25	4.42	16%	33.83	8%
Sc.....	6.75	36.25	6.2	35.75	5.5	36.50	6.17	14%	36.17	4%
Ti.....	3.75	37.50	3.2	39.00	2.5	38.75	3.17	18%	38.42	3%

The very best learner, it is seen, has also the best retention and the most constant and reliable memory, as is shown by her smaller average deviation for retention. The first and second subjects have practically the same retention, although they differ widely in learning, while Sc, with an intermediate learning time, retains better than either Tr or St. This experiment would show that the fast learner at least has no disadvantage in retention. No inference can be made from this table as to the best method of presentation. The experiments were given in the order shown by the table, and the better records noticed in the second and third forms of presentation are doubtless due to improvement through practice, for in our next experiment, in which but one method was used, a constant improvement is shown.

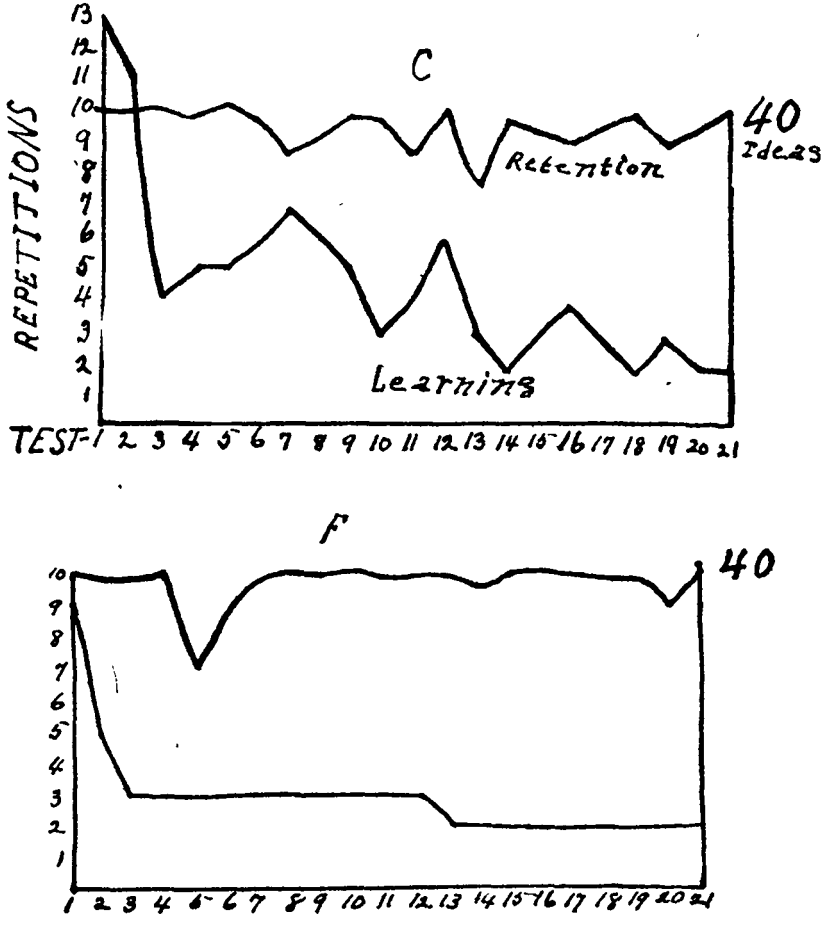
In Table III are shown the results of our most extended experiments. Each subject learned 21 separate segments of material, containing 40 ideas each, and the greatest possible care was taken to keep the conditions constant and uniform for the different subjects. In every case the material was reproduced in writing 24 hours later by the learners.

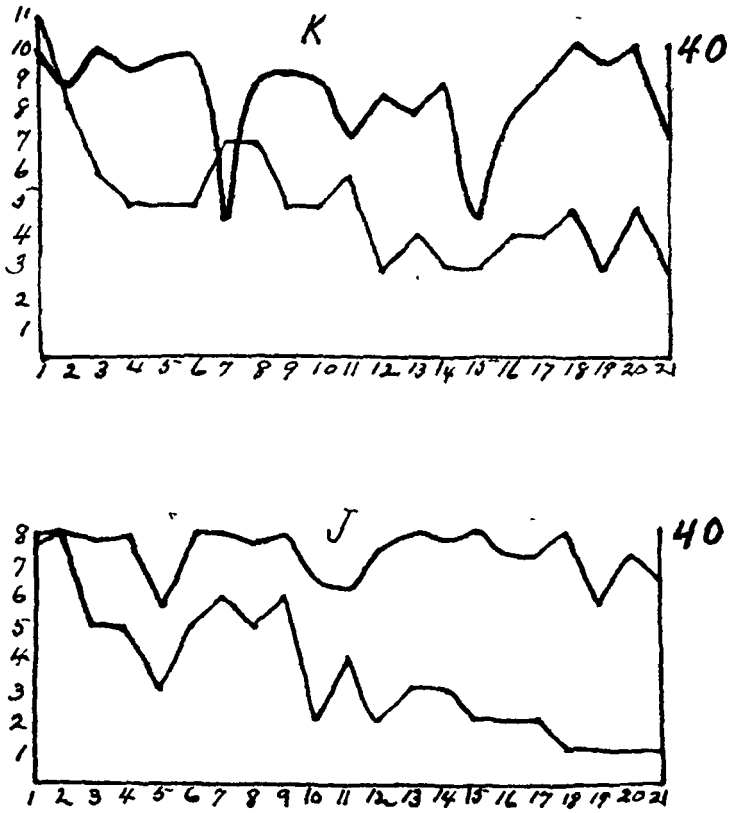
TABLE III. *Material always read to subjects.*

Subjects.	Repetitions.	Av. dev.	Retention.	Av. dev.
C.....	4.7	2.24	37.5	2.0
F.....	2.9	0.78	38.5	1.7
K.....	5.2	1.40	34.2	4.6
J.....	3.6	1.90	36.7	3.2

The results show that the slow learner certainly has no advantage in retention over the fast learner. The differences

in retention, however, are much less than the differences in learning. Our results, therefore, correspond to those obtained by Ogden. This seems to indicate that if the learning of the same material by different learners is carried to the same point of organization there may be little difference in retention. The curves of learning and retention for this experiment show that the same amount of material was learned in shorter and shorter time as the experiments progressed, although the retention remained practically as good for the faster learning as it had been for the slower learning.





Interesting in this connection, for comparison, are the results of an experiment on six subjects in the learning of a series of 25 nonsense syllables, forward and then backward, as shown in Table IV. The procedure was to learn the series at one sitting, by repeating the syllables to the stroke of a metronome, according to the method of Ebbinghaus, then relearning them on the second and succeeding days until they could be said daily from memory. When this point of automatization was reached the series was then learned backward. Four of the subjects were those taking part in experiment 1.

TABLE IV. *Nonsense syllables.*

Forward.				Backward.			
Subj.	Rep. for first learning.	Total.	Ratio.	Subj.	First.	Total.	Ratio.
Wi.....	123	150	1.2	Wi.....	27	38	1.4
Th.....	121	129	1.06	Th.....	79	105	1.3
We.....	118	147	1.2	We.....	72	111	1.5
Sw.....	99	136	1.4	Sw.....	67	89	1.3
Sn.....	72	85	1.2	Sn.....	20	40	2.0
B.....	59	70	1.2	B.....	20	31	1.5
Av.....	96	117	1.2		47.5	69	1.4

Time did not permit the learning of any more syllables in this way, and perhaps no conclusions are warranted on such meager data, but the uniformity of the above ratios is suggestive. The figures in the columns marked "total" were obtained by adding together the number of repetitions for each day's learning until the series could be repeated after 24 hours without looking at the list; that is to say, the learning was carried to the point of fairly permanent automatization.

That the learning backward was relatively harder to carry to the point of automatization was doubtless due to the interference of the habit of saying them forward. It would seem, then, that every person has a definite coefficient of learning capacity, and that the more quickly one can learn, the more quickly one can reduce to automatization, *i. e.*, make the matter permanent. Even if the fast learner had no advantage in retention, he would still, other things equal, have a great advantage over the slow learner, for he can make his acquisition just as fixed and permanent as does the slow learner and have time to spare for learning other things or other aspects of the same thing. It is interesting to compare the average records made by the learners on the first and second readings of each test. In the third experiment the four learners made the following averages on the first reading in the 21 tests: J, 29 points; F, 26 points; C, 17 points; K, 16 points. At the end of the second readings the following averages were made: F, 36 points; J, 35 points; C, 28 points; K, 26 points. Therefore, for these four learners and for the length of test given, two readings give a better index of the complete learning time than does one reading. But a comparison of the detailed records of all our tests with all the observers makes it evident that immediate

reproductions of single readings of subject-matter give a fair idea of a person's complete learning time, provided that the matter be familiar. In our experiments the fast learner was also more accurate; his reproductions would always be nearer to the exact meaning of the original than would the reproductions of the slow learner. Perhaps related to this is the fact that our best learners excelled at committing poetry to memory in a few tests that were given them.

The improvement of memory with practice is very evident from the curves. That the improvement of J is greater than that of the others is perhaps due to the fact that her experiment was spread out over much more time than was that of the other three. J worked three times a week; the others daily except Sunday. Practically all experimenters in this field have found improvement in memory with practice. How general this improvement is is a question on which our experiment throws no light.

The question of the relation of memory to scholarship naturally arises.[1] Some investigators have found a positive correlation; others have not. We have several times tried to find how the matter stood in our own classes, and have found only a slight correlation—something like .30 by the Pearson formula. Yoder (12) thinks geniuses have better than the average memory. If a good memory means good retention, why do we not find a higher correlation between memory and class standing? Doubtless because many factors contribute to good scholarship, memory being only one of these factors. Habits of study, for example, have much to do with class standing. If a slow learner has the habit of going over a lesson or task several times, and a fast learner the habit of giving a lesson but one hasty reading, other things being equal, the slow learner will have the better scholarship. But if the fast learner has good habits of study, goes over a lesson more than once and at different times, so as to get the advantage that comes from initial readings and from repetitions, he will excel in scholarship. As a matter of fact, while we have never found a very high degree of correlation between memory and schol-

[1]See, for a brief discussion and bibliography, Max Offner (6), *Das Gedächtniss*, 1909, p. 219, and Bib.

arship, we have found that the few very best students possess both the best memories and good habits of study. Of course, there are many other factors that make a good student besides the two considered. It is true that our retention tests were given only 24 hours after the learning, and it might be said that in the long run the slow learners would retain the most. We tested the retention of two learners, F and C, in experiment III, one month after the close of the learning, using the even-numbered tests, that is, the second, fourth, and so on, and found that the retention of these two learners was practically the same. We have also tested the retention of the members of large classes a month after matter was given, and found the chances to be at least three out of four that students would maintain the same rank in long retention that they had in immediate reproduction. This fact has an important educational significance. It means that the student who gets the most out of a lecture will have the most on examination day, provided that there is no reviewing or further study. Learning is the important thing. Teachers should try to get the slow learners to put sufficient time on their work to *fix* it. It would seem to be the duty of teachers to determine the kind and strength of memory possessed by their students so that the students could form proper habits of study. It is also important that students know the value of properly learning and organizing subject-matter as they go along, then retention will take care of itself. Other educational implications of this study were published in this JOURNAL for October, 1910 (8).

CONCLUSIONS AND INFERENCES.

1. The fast learner is at no disadvantage in retention.
2. Individuals differ less in retention than in learning ability.
3. Women—in our experiments—do better than men.
4. Every individual probably has a definite coefficient of learning capacity, which is an index of the time necessary for habituation.
5. An immediate memory test probably gives a fair index of permanent retention, also of habituation time, a good record meaning short habituation time and good retention.

6. One habit interferes with another using the same elements in new combinations.

7. The fast learner, in our experiments, is more accurate than the slow learner.

8. Memory improves by practice in the field where it is exercised.

9. There is a slight positive correlation between memory and good scholarship, memory being only one of the factors that make good students.

10. Students should be tested to ascertain the quality of their memory so that they can form proper habits of study.

11. Teachers should endeavor to bring the learning of all students to the same point of automatization. This will mean more work for some students than others.

REFERENCES:

(1) EBBINGHAUS. *Grundzüge der Psychologie.* 1905, p. 682.
(2) E. N. HENDERSON. *A Study of Memory.* Psych. Rev. Mon. Sup., No. 23, 1903.
(3) E. MEUMANN. *Oekonomie und Technik des Gedächtnisses.* 1908, p. 212.
(4) G. E. MÜLLER and F. S. SCHUMANN. *Experimentelle Beiträge zur Untersuchung des Gedächtnisses.* Zeit. f. Psych. d. Sinnesorganne, VI, 1894, pp. 81 and 257.
(5) NORSWORTHY. Note in *The Use of Experiment in Teaching Educational Psychology.* Journal of Ed. Psych., I, p. 288.
(6) MAX OFFNER. *Das Gedächtnis.* 1909, pp. 219 and 227.
(7) ROBERT MORRIS OGDEN. *Ueber den Einfluss der Geschwindigkeit des lauten Lesens auf das Erlernen und Behalten von sinnlosen und sinnvollen Stoffen.* Arch. f. d. gesamte Psych., II, p. 129.
(8) W. H. PYLE. *One Function of the Teacher in Memory Work.* Journal of Ed. Psych., I, p. 474.
(9) JOHN C. SHAW. *A Test of Memory in School Children.* Ped. Sem., IV, 1896, p. 61.
(10) E. B. TITCHENER. *A Textbook of Psychology.* 1910, p. 405.
(11) L. G. WHITEHEAD. *A Study of Visual and Aural Memory Processes.* Psych. Rev., III, p. 258.
(12) A. H. YODER. *A Study of the Boyhood of Great Men.* Ped. Sem., III, p. 150.