RECITATION AS A FACTOR IN MEMORIZING

BY

ARTHUR I. GATES, M.A.

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, in the Faculty of Philosophy, Columbia University

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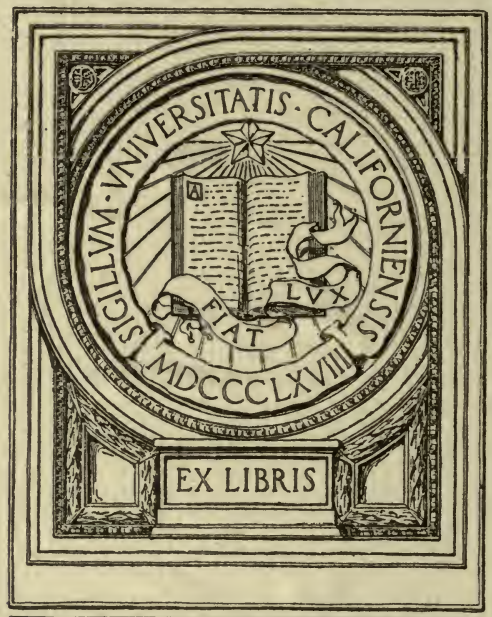
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TABLE OF CONTENTS

Chapter		Page
I.	Introductory statement of the problem.	1
II.	Summary of previous studies on the problem . . .	4
III.	The subjects, materials, and methods of procedure .	24
IV.	Quantitative results	35
V.	An analysis of reading and recitation as factors in learning	65
VI.	Conclusions and pedagogical implications	99

PREFACE

The present investigation was begun in the Psychological Laboratory of the University of California in the spring of 1916. The experiments in which children served as subjects were conducted in a public school in Oakland, California, while those upon adults were, for the most part, carried out in the Psychological Laboratory of Columbia University.

The writer has been fortunate in having enjoyed, during the course of the work, endless encouragement, suggestions, and assistance from a large number of people. To Mr. N. Ricciardi, Principal of the school visited, I am indebted for the privilege of conducting the experiments upon his charges as well as for the ready help in arranging details for the work. To the many teachers whose class-rooms I invaded, I am indebted for the kindliest toleration and for a great deal of valuable assistance. My debt of gratitude to Professors G. M. Stratton and Warner Brown of the University of California and to Professors J. McKeen Cattell, R. S. Woodworth, E. L. Thorndike, H. L. Hollingworth, and Dr. A. T. Poffenberger of Columbia University, is very great. To my friend Charles E. Martin, I am indebted for valuable suggestions and criticisms in the preparation of the manuscript.

I

INTRODUCTORY STATEMENT OF THE PROBLEM

The process of learning as carried on by most adults depending upon their native resources or practical experience, is frequently interrupted by attempts at recitation or voluntary recall of what has been learned. We tend to introduce an attempt at recitation at the earliest possible moment, usually long before a perfect reproduction is possible. In that case, as a rule, we refer promptly to the material being studied in order to complete the perusal. For example, many years ago Francis Bacon observed, "If you read anything over twenty times you will not learn it by heart so easily as if you were to read it only ten, trying to repeat it between whiles, and when memory failed looking at the book." [1] The spontaneous methods of learning of many people resort so naturally to these attempted reproductions that we can hardly refuse to believe that they are helpful. Yet most of us would admit that the dominating idea behind such a procedure is the fear of studying the lesson more than is absolutely necessary, and it is by no means clear that introducing the recitation too early in the learning process may not result in loss of time. This gives rise to several practical questions, such as:—Is an attempted recitation of as much value in learning as another perusal or reading, and is a recitation at one stage of the learning as valuable as at another?

It is at once obvious that the solution of such questions is of tremendous import for the work of the school. It is imperative that recall or recitation, as a factor in learning, should be analysed and its quantitative importance determined. Although several studies of the problem have been made within the last decade, facts that will permit indisputable application to the work of the school-room are still wanting. The amount of experimentation required to solve the problem adequately is much greater than would at first thought appear, since different results might be expected according to the age and training of the subject, the kind of material employed, the length of the lesson or the purpose of the learner, *i. e.*, whether the material is to be 'learned by heart' or only partly learned. The general condition of the problem is indicated by a recent statement of Meumann, who, after summarizing the work in the field, con-

[1] *Novum Organum*, 1620, translated by James Spedding, edition of 1863, p. 229.

cluded that[2] "it is indispensable that such experiments be repeated and confirmed before the results are applied to pedagogy."

That great variations in the methods of learning exist even among adults with college training will be surprisingly evident to anyone who will select at random twenty such individuals and carefully observe the means employed in learning a stanza of poetry or a series of nonsense syllables. Many cases of alleged 'poor memories' may prove to be due to poor methods of study. One would even more confidently expect to find among children a greater number of ineffective methods of studying. In fact Miss M. J. Baldwin made a study of this matter[3] and found that such was the case. She undertook, by means of questionnaires and observations of pupils in Grammar and High School, to determine the methods of study as well as the methods employed in testing their attainment. The methods of study, as one might expect, were various. Some employed one kind or another of attempted recall, such as trying to say or write the main ideas, but more than one-fourth simply read the lesson through time after time. In some classes from fifty to sixty per cent. of the pupils came to the recitation without having once attempted to test their mastery of the lesson in any definite way.

Manifestly, when so many of our years are to be spent in studying, it is imperative that some information concerning such broad functions as reading and recitation as factors in learning should be obtained and applied. While volumes have been written on methods of study and on the economy of learning, so far as children are concerned, no objective data are available demonstrating the relative value of these two functions which are fundamental in any attempt to learn. Earlier investigators have found in the case of many adults that the optimum combination of recitation and reading may lead to the mastery of a given lesson in one-half the time required to learn it by reading alone. If such findings should hold for children, and if it is generally true, as Miss Baldwin found, that twenty-five per cent. or more of the pupils in the schools rely entirely upon reading in their learning, the loss of time and energy is appalling.

The present study presents the results of an effort to answer a practical problem of the school-room—namely, What are the relative values of learning by reading as compared to learning by recitation in the case of school children working under school conditions and with the ordinary school-room methods of attack? It will be seen later that all the previous work on this subject has employed adults as

[2] *Vorlesungen zur Einführung in die experimentelle Pädagogik*, vol. III, 1914, p. 130.

[3] 'Studies in Development and Learning', *Archives of Psychology*, 1909, No. 12, pp. 65–70.

subjects. But as Meumann has said,[4] "We do not know whether recitation is of the same value for children, nor whether the combination of readings and recitations for optimum results is the same as for adults." In most cases, moreover, the earlier researches were conducted under rather rigorously controlled conditions. The subjects were not permitted to study in their habitual manner; sometimes the material was presented tachistoscopically with a fixed tempo of presentation, sometimes articulation was prohibited or other restrictions enforced. In the present work, so far as practicable, conditions were made as nearly normal as possible. The material selected is comparable to that with which the pupils were accustomed to deal in their daily work. The children studied in much the same manner that they would employ in learning a vocabulary, a spelling lesson, or a history or geography lesson, with the knowledge that at the end of the study period they would be given a written examination. Details of material and methods, however, will be reserved for a later page.

In addition to the experiments upon school children, adult subjects were also tested with similar materials and methods. The data thus obtained will make possible a more adequate comparison of the present findings with those of other investigations and will be of assistance in better interpretation of the results by virtue of the more reliable introspective observations which would be expected from the more experienced learners.

From this study it is hoped that some information will be secured on the following points:

1. The relative value of learning by reading as compared to learning by recitation.
2. The differences in the functions involved in the two methods of learning.
3. The optimum time at which to introduce recitation into the learning process.
4. The relation of the two methods of learning as dependent upon the age or school status of the learner.
5. The relation of the two methods as dependent upon the kind of material employed.
6. Incidental information concerning the learning methods of children and adults.

In the next section a brief summary of the work previously done on the problem will be presented.

[4] *Op. cit.*, vol. III, p. 130.

II

SUMMARY OF PREVIOUS STUDIES ON THE PROBLEM

In 1908 M. Dimitre Katzaroff made a direct attempt[1] to obtain evidence upon the relative value of reading as compared to recitation as factors in the learning process. Series of eight or ten pairs of nonsense syllables were presented serially on a drum which revolved so as to expose each pair for two seconds. A four-second pause was made between perusals. Adult subjects were employed exclusively, each learning three or four series at each sitting, a rest of five minutes being given between series. After a certain number of readings attempts were made at recall by exposing the first word of each pair and calling for the second word. Each syllable was left in view for twenty seconds unless its associate was recalled earlier, and in cases of failure to recall the learner was prompted orally. Various combinations of study and recitation were tried as may be seen from Table I.

The test of memory was made by the 'Treffer' method, the original first members, however, being exposed in a new order after intervals of twenty-four, forty-eight, or seventy-two hours. The time required for each response was measured by a Muensterberg chronoscope. Table I gives a summary of the results.

The general result of these experiments is that recitation, after a certain number of original readings, is more valuable than additional readings. In most cases, the advantage of recitation is very great, measured by the amount correctly recalled, and usually the reaction time is less. Tables D and E also show quite conclusively that recitations grouped are more effective than recitations interspersed with readings.

The greater effectiveness of recitation is explained by Katzaroff as being due in the main: *First*, to a greater control over the conditions of learning. *Second*, to a greater activity of the learner during recitation, "in the readings, the subject is passive, calm, indifferent; in recitations he is active, he has to seek, he rejoices when he has found and is irritated at the syllables which evade his call."[2] *Third*, to a greater confidence with reference to the material learned which is brought about by recitation.

[1] 'Le Rôle de la récitation comme facteur de la mémorisation', *Archives de psychologie*, 1908, 7 pp.224–259.

[2] *Op. cit.*, p. 257.

For several reasons, it would be unsafe to consider Katzaroff's findings as typical. In the first place the results were obtained from too few and highly trained adults. Individual peculiarities may play too prominent a rôle. Moreover, practice effects were not sufficiently taken into account, and finally the mode of presentation was not the same in the two methods. During the perusals by reading the total presentation was visual, but during recitation oral

TABLE I

Showing a summary of results obtained by Katzaroff, op. cit.

Table	Number of subjects	Number of sittings for each	[3]Combination L reading R recitation	Test after number hours	Per cent. correct	Reaction time in seconds
A	1	4	L 10 R L5	48	43	5.6
			L 10 R R5		50	4.0
B	3	4	L8 L7	72	6	8.0
			L8 R7		20	6.7
C	2	4	L8 L7	72	9	7.8
			L8 R L6		15	8.6
D	1	3	L4 L6	24	17	5.0
			L4 R6		46	2.9
			L4 RL RL RL		25	4.5
E	1	3	L4 L6	24	4	2.9
			L4 R3 L3		62	3.1
			L4 RL RL RL		54	2.9

presentation was added to the visual, since the prompts were made by means of the experimenter's voice.

A more recent experiment by Thorndike[4] has given very different results. Twenty-eight adult students learned four vocabularies of twenty pairs each, the second by attentive reading and rereading, the first by reading the first members and trying to recall the second members of the pairs. The third vocabulary was learned in the same manner as the second, and the fourth in the same manner as the first. The results are given in Table II.

There is no apparent superiority in the method involving recall; in fact, the method of reading and rereading seems to give slightly better results. Professor Thorndike explains that "This, however, was partly due to the overlearning of the first vocabulary, there

[3] For the sake of brevity, let L equal reading and R equal an attempted recitation. Thus L10 R5 means ten original readings followed by five attempted recitations.

[4] 'Repetitions versus Recall in Memorizing Vocabularies', *Journal of Educational Psychology*, 1914, 5, pp. 596–597.

being a tendency to take profitable risks in the vocabularies after the first." And moreover, "The experiment was too crude and too slight to give numerical results worth presenting in detail."

A more extensive study has recently been reported by Alexander Kühn.[5] Three kinds of material were employed: vertical rows of

TABLE II

Recall		Reading		Reading		Recall	
Time (seconds)	Number correct	Time (seconds)	Number correct	Time (seconds)	Number correct	Time (seconds)	Number correct
18.6	13.9	16.1	16.9	15.8	15.7	14.7	14.6

twelve nonsense syllables, vertical rows of twelve one-syllable substantives, and short verses. Two methods of studying were employed, one in which the learner read and reread until he was confident of his mastery of the material and another in which the subject was permitted to employ recitation as soon as he desired.

TABLE III

Material	Method of learning[6]	Tempo Controlled				Tempo Free			
		Number of repetitions		Time		Number of repetitions		Time	
		Average	Median	Average	Median	Average	Median	Average	Median
Verses	R	7.5	7.3	2′09″	2′06″	6.5	6.4	1′51″	1′49″
190 tests	L	8.8	8.8	2′26″	2′25″	8.2	8.2	2′19″	2′15″
6 subjects	L—R	1.3	1.5	17″	19″	1.7	1.8	28″	26″
Words	R	15.3	14.6	2′35″	2′31″	11.2	10.9	2′04″	2′01″
132 tests	L	20.8	20.4	3′24″	3′21″	18.8	18.7	2′59″	2′58″
9 subjects	L—R	5.5	5.8	49″	50″	7.6	7.8	55″	57″
Syllables	R	22.7	22.7	3′56″	3′56″	18.1	17.7	3′33″	3′38″
132 tests	L	36.6	36.7	6′06″	6′09″	31.8	31.7	5′22″	5′17″
9 subjects	L—R	13.9	14.0	2′10″	2′13″	13.7	14.0	1′49″	1′49″

In some experiments the tempo of presentation was controlled by means of a metronome, the subjects being required to repeat a word or a nonsense syllable each 0.65 of a second, while in the case of poetry a syllable was repeated each 0.4 second. In other tests, the subjects studied in their preferred tempo. In all cases, simultane-

[5] 'Über Einprägung durch Lesen und durch Rezitieren', *Zeitschrift für Psychologie*, 1914, **68**, pp. 396–481.

[6] R—recitation, L—reading. Sum of tests for all subjects.

ous visual presentaton was employed, the subjects prompting themselves and correcting their own errors. For the learning of syllables and words, trochaic rhythm was specified. The subjects were university graduates and instructors. Each subject learned a dozen or more lessons by each of the two methods. Table III gives a summary of the results.

Table IV gives the relation of reading minus recitation to recitation, computed from the data of Table III.

TABLE IV

The Relation of Reading minus Recitation to Recitation

Material	Tempo controlled				Tempo free			
	Repetitions		Time		Repetitions		Time	
	Average	Median	Average	Median	Average	Median	Average	Median
Verses	0.17	0.20	0.13	0.15	0.26	0.28	0.25	0.24
Words	0.36	0.40	0.31	0.33	0.68	0.71	0.44	0.47
Syllables	0.61	0.62	0.55	0.56	0.76	0.79	0.51	0.52

The general result is that for all materials recitation is a more effective method of learning than reading only. Rather striking individual differences, however, were found, ranging all the way from certain subjects who required more than twice as long to learn a series of nonsense syllables when no recitation was permitted, to others (in all three subjects out of thirteen) for whom reading was an equally or even more effective method of learning than recitation. The latter are representative of a peculiar type of mechanical learners to whom we shall refer again. On the whole, however, the advantage of recitation is clear.

It appears that the advantage of recitation differs considerably according to the kind of material being studied; the more senseless and less connected the material, the greater the advantage of recitation over reading. Thus, Table IV shows the superiority of recitation to be rather small in the learning of verses, about twice as great for learning series of words, and larger still for learning nonsense syllables. The advantage of recitation also differs according to the method of studying that is employed, being in all cases greater when the learner is left to employ his own tempo than when the tempo is controlled by the experimenter. It was found also that in the reading method the subjects were unable to judge so well when the material was mastered and often 'made too early an attempt to recite'. In general, it was found that the controlled tempo hampered the learning to a greater or less extent.

After a lapse of twenty-four, forty-eight, and ninety-six hours, the material was relearned, the same methods being employed that were used in the original learning. Table V shows the average results for six subjects.

TABLE V

After twenty-four hours. Total number of tests—84

Method	Tempo controlled				Tempo free			
	Repetitions		Time		Repetitions		Time	
	Average	Median	Average	Median	Average	Median	Average	Median
R	4.1	4.0	1′06″	1′05″	3.8	3.8	1′00″	0′58″
L	5.0	5.0	1′21″	1′20″	4.6	4.6	1′12″	1′12″
L—R	0.9	1.0	15″	15″	0.8	0.8	12″	14″
After forty-eight hours. Total number of tests—68								
R	3.9	3.8	1′03″	1′02″	3.7	3.7	0′57″	0′55″
L	4.5	4.4	1′14″	1′13″	4.5	4.3	1′12″	1′12″
L—R	0.6	0.6	11″	11″	0.8	0.6	15″	17″
After ninety-six hours. Total number of tests—38								
R	3.8	3.9	1′03″	1′02″	3.3	3.3	0′53″	0′52″
L	4.8	4.9	1′21″	1′20″	4.4	4.6	1′12″	1′15″
L—R	1.0	1.0	18″	18″	1.1	1.3	19″	23″

The results indicate the superiority of recitation as a factor in relearning but do not show that the material learned by the recitation method is better retained than the material memorized by reading alone. In the case of a few individuals, tests were made after various intervals by the 'Treffer' method. From the data given by Kühn (p. 463) the following averages for ten subjects have been computed:

TABLE VI

Per cent. of material recalled after an interval of from five to ten minutes. Test by 'Treffer' method

Method of learning	Lists of words		Lists of syllables	
	Tempo controlled	Tempo free	Tempo controlled	Tempo free
R	66.8	72.3	36.4	32.6
L	59.3	56.7	25.4	22.7
L—R	7.5	15.6	11.0	9.9

It is apparent that the material learned by recitation is better retained. In the case of words, material learned by means of a fixed tempo is not so well retained as material learned by a free tempo, but this result is not clear for nonsense material, for which the opposite, if anything, is true.

Three subjects were each given twelve tests by the 'Treffer' method first after ten minutes and again with other material after twenty-four hours. The results are given below.

TABLE VII

Per cent. of material recalled after ten-minute or twenty-four-hour lapses
Studying done with free tempo

After ten minutes		After twenty-four hours	
Reading	33.5	Reading	6.2
Recitation	44.1	Recitation	11.9

From this data, Kühn concludes "the advantage of learning with recitation for retention is much greater after a pause of a day than after a pause of a few minutes." [7]

Kühn found a great deal of interesting information concerning individual peculiarities in learning. Many individuals had a constant tendency to begin to recite too soon, or too late, for the best results; some were unable to limit themselves to 'pure' reading, more or less recitation unintentionally creeping in; some subjects were found who seemed to derive no benefit whatever from continued readings beyond a maximum of four or five; and others obtained better results under the reading method than when recitation was a factor. Kühn found the latter subjects to employ a peculiar form of 'automatic' or 'mechanical' method of learning, in which the usual method of building up associations between items and binding them into some form of compact 'schema' or structure was not employed. Simple visual imprinting was the most effective procedure.

Kühn came to the general conclusion, "that recitation is more effective because it leads to a more fundamental, many-sided working over of the material" (p. 443). In recitation the items are more attentively observed, the list is more carefully analysed, striking words are picked out, and a better 'schema' of reconstruction is employed. In the case of those individuals who rely upon the various sorts of associative aids in learning, recitation is very helpful, but the few who learn mechanically can do as well or better by merely reading.

[7] *Op. cit.*, p. 466.

So far no information has been cited with regard to the stage at which it is best to introduce the first recitation. This question was taken up and answered, in a measure, by Witasek.[8] Rows of ten pairs of nonsense syllables were exposed successively at the rate of one per second by means of a Wirth memory apparatus. The subject studied aloud both in reading and recitation, and all corrections and promptings were made orally by the experimenter.

TABLE VIII (from Witasek, p. 267)

Showing the superiority of a group of recitations over a group of readings, absolutely and relatively [9]

Number of preliminary readings	Superiority in number of repetitions		Superiority in number of seconds		Superiority in number of prompts	
	Absolutely	Relatively	Absolutely	Relatively	Absolutely	Relatively
			Of five recitations over five readings			
6	2.3	90 per cent.	87	90 per cent.	4	80 per cent.
11	2.0	80 per cent.	73	80 per cent.	6	100 per cent.
16	1.4	70 per cent.	54	70 per cent.	3	60 per cent.
			Of ten recitations over ten readings			
6	1.5	70 per cent.	62	70 per cent.	5	80 per cent.
11	2.0	60 per cent.	61	60 per cent.	3	60 per cent.
			Of fifteen recitations over fifteen readings			
6	1.8	60 per cent.	62	60 per cent.	4	60 per cent.

In the case of recitation, however, the first syllables of the pairs were spoken by the experimenter. An interval of six to seven seconds was given between repetitions. Three series of syllables were learned each day, a three-minute rest being allowed between lessons. The method of computation used by Witasek is, in many cases, somewhat confusing. He frequently makes use of the term 'imprinting value' ('Einprägungswert') which means the value of

[8] 'Über Lesen und Rezitieren in ihrer Beziehungen zum Gedächtnis', *Zeitschrift für Psychologie*, 1907, **44**, pp. 161–185, 246–278.

[9] To make the meaning of the table clearer the procedure may be described more in detail. To begin with, the lists were read six, eleven, or sixteen times as indicated. One hour later, the lists were in one case read, and in the other case, recited, five, ten, or fifteen times as indicated, and immediately after the learning of the lists was completed by further recitations. From these data, the saving in the total time required to learn was computed for the groups of readings and for the groups of recitations. The table above presents, absolutely and relatively, the *differences* between the savings brought about by reading and by recitation—the differences always being in favor of the groups of recitations as shown.

a repetition in reducing the time or repetitions needed to complete the learning. Table VIII shows the superiority of a group of recitations over an equal group of readings, after a given number of preliminary readings, in reducing the time required after an interval of an hour, to complete the learning so that the entire list could be recited without prompts in ten seconds or less. The table is based upon the work of seven university graduates and faculty members, tested three or four times, a total of twenty-four tests.

The table shows in summary form a finding which is demonstrated in more detail by Witasek, *e. g.*, that the imprinting value of successive readings declines very rapidly after the first few. That

TABLE IX (from Witasek, pp. 184–185)

Number of original readings	Number of additional readings	Number of recitations	Total repetitions	Speed of recitations after one hour	Number of prompts
6	0	0	6	78″	7.9
6	5	0	11	75″	7.2
6	0	5	11	63″	6.3
6	0	10	16	69″	5.8
6	10	0	16	74″	7.5
6	5	5	16	66″	6.0
6	0	15	21	66″	5.5
6	15	0	21	73″	6.7
6	5	10	21	65″	5.9
6	10	5	21	66″	5.7
6	10	10	26	69″	5.7
6	5	15	26	65″	6.2

is to say, readings are pronouncedly subject to a law of diminishing returns. In this respect, recitations proved to be a better form of repetition. It is apparent, from the table, that recitations introduced into the learning at almost any point are of more value than continued readings. However, the superiority of recitation seems to be somewhat greater when introduced after six than when introduced after eleven or sixteen readings. This would seem to indicate that recitations, too, are subject decidedly to the law of diminishing returns. But Witasek explains that in these particular tests with a large number of repetitions "the readings unconsciously become very similar to recitations." The learner, finding the readings to become more and more fruitless, is unable to restrain a natural inclination to partially recite.

So far experiments have merely confirmed the current opinion that recitations, if not introduced too early in the learning process,

are of more value than continued readings. It remains to enquire into the combination that will yield the richest returns in proportion to the outlay of time and energy. Table IX shows the relative effectiveness of several combinations as measured by the speed of the first recitation after an interval of an hour, together with the number of prompts. The procedure in this recitation was as follows: The first member of each pair was exposed, the subject responding with the second member, whereupon the first member of the next pair was exposed and so on. If the subject responded incorrectly, he was corrected by the experimenter, and if the subject could not

TABLE X (from Witasek, p. 184f)

Number of original readings	Number of additional readings	Number of recitations	Total repetitions	Speed of third recitation after one hour	Number of prompts
6	0	0	6	37″	1.8
6	5	0	11	34″	1.7
6	0	5	11	22″	0.8
6	0	10	16	20″	0.8
6	10	0	16	32″	1.6
6	5	5	16	19″	0.5
6	0	15	21	15″	0.5
6	15	0	21	27″	0.5
6	5	10	21	18″	0.7
6	10	5	21	19″	0.7
6	10	10	26	20″	0.9
6	5	15	26	16″	0.4

respond at all within ten seconds, the experimenter gave the response orally and exposed the next syllable in the series.

The results shown in this table are not very clean cut and in some respects are rather surprising. Within the various groups showing an equal number of repetitions, it is quite clear that a combination of recitations with readings leads to a more successful recitation after an hour than when reading only was employed in the study period. The advantage does not appear to be very great, however. What is quite surprising is that a small number of repetitions of any sort (six or eleven) leads to nearly as effective a recitation after an hour as a larger number (sixteen, twenty-one, or twenty-six). From this it would appear that repetitions beyond eleven are pretty largely wasted, and accordingly recitation, contrary to Witasek's earlier contention, must be subject also to a law of greatly diminishing returns.

The above table (Table X) which was computed from Witasek's original data, shows that the results for the third attempted

recitation after the interval of an hour are quite different from those based on the first recitation after the interval. The second, fourth, or fifth recitation would have shown a similar difference.

In the case of these later repetitions, the advantage of recitation as a factor in the original learning is quite pronounced. It is apparent also, that although the law of diminishing returns is still seen to operate, its influence is very much less marked than appeared in the results for the first recitation after the interval.

Table XI exhibits the results in terms of the total time required to learn the series in two sittings separated by an hour.

TABLE XI (from Witasek, p. 274)

Work of the first sitting				Work of the second sitting			
Combination	Time of reading	Time of reciting	Pauses between repetitions	Time in recitations	Pauses between recitations	Sum with pauses	Sum without pauses
L6 R0	60	0	35	262	56	413	322
L11 R0	110	0	70	236	49	465	346
L16 R0	160	0	105	228	42	535	388
L21 R0	210	0	140	202	42	594	412
L6 R5	60	96	70	143	28	397	299
L6 R10	60	166	105	163	35	529	389
L6 R15	60	206	140	133	28	567	399
L11 R5	110	80	105	145	28	468	335
L11 R10	110	119	140	124	21	514	353
L11 R15	110	142	175	109	14	550	361
L16 R5	160	69	140	142	21	532	371
L16 R10	160	121	175	153	28	637	434

Table XII shows the data of Table XI rearranged, the combinations being arrayed in the order of their effectiveness with the percentages of time devoted to reading and to recitation.

The findings indicate that a small amount of work at the first sitting pays better than a large amount; that is to say, the series can be learned more quickly in the end if only a small proportion of the total time is devoted to the first study while the larger portion is saved for the review an hour later. There is considerable evidence that better results are obtained if the original study period is partly devoted to recitation; for example, 6 *Ls* plus 5 *Rs* gives better results than 11 *Ls;* 11 *Ls* plus 5 *Rs* is much better than 16 *Ls* and so on. However, the most potent factor is the distribution of the recitations. The best results are obtainable when the original period includes about twenty-five per cent. of the total learning

TABLE XII (based on Table XI)

Combination	First sitting		Second sitting		
	Per cent. of time for reading	Per cent. of time for recitation	Per cent. of time for recitation	Sum with pauses	Sum without pauses
L6 R5	24	33	43	397	299
L6 R0	23	0	77	413	322
L11 R0	39	0	61	465	346
L11 R5	39	24	37	468	335
L11 R10	35	37	28	514	353
L6 R10	18	45	37	529	389
L16 R5	50	20	30	532	371
L16 R0	50	0	50	535	388
L11 R15	33	45	22	550	361
L6 R15	17	55	28	567	399
L21 R0	59	0	41	594	412
L16 R10	42	30	28	637	434

time, allotting about half of this time each to reading and to recitation. Beyond this amount, recitations introduced into the review are much more effective than recitations in the first period of study.

On the whole, so far as the matter of the relative values of reading and recitation as factors in learning are concerned, Witasek's method of attack is subject to several defects. In the first place, too many variable factors are introduced. The influence of various divisions of the lesson, without regard to the methods of study employed, makes interpretation difficult. Moreover, as Witasek himself points out, the conditions of the experiment were such that the readings, especially after a number of perusals, became, unintentionally, very much like recitations. Witasek's procedure may also be charged with most of the defects found in Katzaroff's experiments; in reading, the subject prompted himself by looking at the forgotten syllable, but during recitation, promptings were made orally by the experimenter; the subjects were few and all were trained adults, whose habitual mode of studying may have been seriously interfered with by the particular conditions of the experiment; and finally practice effects were by no means fully eliminated.

From his study, Witasek drew the general conclusion that recitation, as compared to reading, is a much more effective method of study. The difference in favor of recitation was attributed in the main to a 'higher degree of attention' which was made possible by virtue of the opportunity afforded the subject to gauge his progress in the learning and apply himself to the portions that offered diffi-

culty. The higher grade of attentiveness is closely correlated with an apparently 'greater activity' shown during recitation. In reading the subject is likely to relax into a state of passive receptivity, in recitation, the attitude is one of alert, searching (*'sich besinnen'*) activity.

In an experiment by Miss Abbott,[10] the problem has been attacked from a somewhat different point of view. Miss Abbott endeavored to determine the learning types of a limited number of individuals and to utilize this information in the interpretation of the numerical results. As material, lists of thirty nonsense syllables and sixty English words were used. An apparatus was provided such that the words or syllables could be exposed singly for any time desired. A fixed time (sixteen minutes) was allowed for the study period, this time being divided up into various combinations of reading and recall.

The groups of words and syllables were presented in various ways as shown in Table XIII.

TABLE XIII

Series	First eight minutes spent in	Exposure time per item	Interval between items	Interval between first and second learning period	Second eight minutes spent in
a	visual imprinting	1″	0	1′	visual imprinting
b	"	1″	0	15′	"
c	"	1″	0	45′	"
d	"	1″	0	1′	Recall
e	"	1″	0	15′	"
f	"	1″	0	45′	"
g	"	1″	0		
h	visual imprinting and recall	1″	3″	1′	visual imprinting and recall
i	visual imprinting and recall	1″	3″	15′	visual imprinting and recall
j	visual imprinting and recall	1″	3″	45′	visual imprinting and recall
k	visual imprinting and recall	1″	3″		

All series were allotted a sixteen-minute study period except series g and k which received but eight minutes. In series a, b, c, and g no opportunity is given for recall, the whole time being spent in 'Einprägung'; in series d, e, and f the first eight minutes is

[10] 'On the Analysis of the Factor of Recall in the Learning Process', *Psychological Review Monograph*, 1909, **11**, pp. 159–177.

spent in imprinting followed by eight minutes of recall; while in series h, i, and j, three-fourths of the time is devoted to recall, which is interspersed with the 'Einprägung' occupying the three-second intervals indicated in the table.

In all cases the subjects worked under certain restrictions. During the presentation of the material in series a, b, c, d, e, f, and g, the subject was not to form any associative links between the items and while one item was before him, he was not to think of another. During the recall period in the d, e, f series, while the subject was permitted to image the items and form such associations

TABLE XIV (from Abbott, p. 173)

Percentages of words and syllables correctly recalled after four hours

Series	a	b	c	d	e	f	g	h	i	j	k	Subject
Words	23	23	24	23	33	25	23	41	59	42	8	V
Syllables	42	38	40	35	40	17	22	68	92	70	47	
Words	8	8	13	29	12	8	5	97	98	97	62	W
Syllables	20	15	12	20	30	27	8	97	97	98	62	
Words	15	28	23	28	15	18	13	31	34	30	18	X
Syllables	13	13	22	22	17	18	5	30	27	48	10	
Words	67	78	83	48	42	43	28	53	55	17	23	Y
Syllables	67	53	70	67	63	50	57	63	67	53	43	
Words	54			61				56				Z
Syllables	60			50				55				

as he wished, he was not allowed to pronounce them or to write them down.

Five students of psychology acted as subjects in the tests. The image type of each was determined as follows: Subject *V* employed inner speech and concrete visual imagery; Subject *W* was of a motor-auditory verbal type; *X*, motor-auditory with some visual imagery; *Y* was strongly visual, never pronounces a word, just lets it 'soak in'; and *Z* was of mixed type, employing different kinds of imagery at different times.

The test of memory consisted in requiring the subjects to write, four hours after the test, all the words or syllables they could remember. Table XIV shows the results in the form of percentages of the total lists that were correctly reproduced.

Table XV was derived from Table XIV by subtracting the results obtained in series g, from the results obtained in series a, b, c, d, e, f, respectively. This table, consequently, presents the gain

brought about by the second eight minutes of reading or recall as compared to the results obtained by the first eight minutes imprinting alone.

TABLE XV (from Abbott, p. 173)

Showing the advantage of sixteen minutes study over eight minutes

Series	a	b	c	d	e	f	Subject
Words	0	0	1	0	10	2	V
Syllables	20	16	18	13	18	—5	
Words	3	3	8	24	7	3	W
Syllables	12	7	4	12	22	19	
Words	2	15	10	15	2	5	X
Syllables	8	8	17	17	12	13	
Words	39	50	55	20	14	15	Y
Syllables	10	—4	13	10	6	—7	

Table XVI gives the results for words and syllables combined together with the averages for a, b, c; d, e, f; and h, i, j, respectively, based on the data from Table XIII.

TABLE XVI (from Abbott, p. 174)

Showing the combined results for words and syllables

Series	a	b	c	Average	d	e	f	Average	h	i	j	Average	g	k	Subject
	29	28	29	*29*	27	35	22	*29*	50	70	51	*56*	23	21	V
	12	11	12	*11*	26	18	14	*19*	97	98	97	*97*	6	62	W
	14	23	23	*20*	26	16	18	*20*	31	32	36	*35*	10	16	X
	67	70	79	*72*	54	49	46	*49*	57	59	29	*48*	38	30	Y

From Table XV it appears that with the exception of three cases the additional eight minutes of reading or recall results in a greater amount of material recalled, and for all subjects except Y, the value of the additional study is more pronounced in learning nonsense syllables than in learning words.

The most significant comparisons appear in Table XV. Subject *W*, of auditory-motor type, does much better in series h, i, j, than in d, e, f, which in turn gives better results than a, b, c. That is, the methods restricting learning to visual imprinting alone are the poorest of all; the method giving eight minutes of imprinting followed by eight minutes recall is much better; while the method

giving three-fourths of the time to interspersed recall gives results about nine times as good as the first. Subjects *V* and *X* agree in showing sixteen minutes of visual imprinting to be as effective as eight minutes of imprinting followed by eight minutes of recall, but each shows to better advantage when three-fourths of the time is spent in interspersed recall (series h, i, j). These subjects ordinarily employed auditory-motor imagery or inner speech and were undoubtedly greatly hampered by some of the restrictions placed upon them in the d, e, f series. Subject *Y*, who possessed strong visual imagery, learning by simply allowing the items to 'soak in', does very well in the method of visual imprinting and very poorly in either method employing recall.

From this study, Miss Abbott draws the following conclusions:

1. That the factor of recall is always an aid in the learning process.
2. That when recall comes after the *Einprägung* of the material, immediate recall is of more value than delayed recall and its value decreases as the delay increases in length.
3. That the recall is of greater value when it is interspersed with the *Einprägung*.
4. That localization is one of the factors which go to make recall an aid to memory, but that the relative importance of this factor is determined by individual type.
5. That the relative value of recall and *Einprägung* depends on individual type.

To the present writer, it seems that the third conclusion, *e. g.*, "That recall is of greater value when it is interspersed with the Einprägung," is not entirely borne out, at least not in such form as to be applicable to every-day, non-restricted methods of learning. In the first place, the methods employing the interspersed recall devote twenty-five per cent. more time to it than do the methods in which the recalls are grouped. Again, the severe restrictions placed on the first eight minutes of learning by reading in the series a, b, c, d, e, and f are avoided in the series in which recall is interspersed with reading. It will be recalled that Katzaroff in experiments in which restrictions were less severe, and employing a larger number of subjects, found that recitations grouped gave better results than recitations interspersed with readings. (See p. 5.)

A study by Clemens Knors,[11] although not primarily concerned with the present problem, contributes some information concerning three different methods of memorizing paired material. *Method A* is similar to the 'reconstruction method' introduced by Miss

[11] 'Experimentelle Untersuchungen über den Lernprozess', *Archive f. d. g. Psychologie*, 1910, **17**, pp. 297–362.

Gamble.[12] The series was first read through once, the subject then attempted to recite both members of the pairs; the series was then read again, followed by another attempt at reconstruction and so on until learned. *Method B* was the same except that, in recitation, the first members of the pairs were exposed, the learner attempting to recite the second members only. In *Method C* the subject read and reread the series until he felt that they were mastered; whereupon he was tested by exposing the first members of the pair as in *Method B*. It will be noted that *Method A* permits the recitation of both members of the pairs, *Method B* of but the first member, while *Method C* permits no recitation during the learning.

In all methods the subject read or recited aloud, the number of perusals and the number of promptings being recorded. The scores are given in the form of the total amount of material that was read by the subject plus the amount supplied him in the form of promptings or corrections by the experimenter. The following sample will show how the score was computed. Suppose a series of fourteen syllables is learned by eight readings plus seven attempted recitations, during which fifty-one syllables were supplied by the experimenter. Then the total score would be eight (the number of readings) plus fifty-one (the total number of prompts) divided by fourteen (the number of syllables in the list). That is, score = $8 + 51/14 = 11.64$.

From the original data given by Knors, the results shown in Table XVII have been computed. Unfortunately Knors did not print all of the raw data that he collected, so that some of the tables are incomplete. The subjects are three adults (A, B, C) and four children (a, b, c, d) eleven to thirteen years of age. The table presents the average score of three or four tests for each individual.

Although the results are somewhat irregular, a few points can be made out. Sections *H* and *I* indicate that, for adults, *Method A*, which requires the recitation of both members of the pairs, is superior to *Method B*, in which but the second member is recited. For Subjects *A* and *C* the differences are very great. The same subjects, however, show but a slight superiority of *Method A* over *Method C* in which reading alone was involved.

Although the findings for the children are very irregular, some differences between the methods seem clearly to appear. When the series of nonsense syllables to be learned is long (Section L), *Methods A* and *B* are both superior to *C*, which permits reading only; but when the series is short (Section *M*) the differences are very small. The differences between *Methods A* and *B* in either

[12] 'A Study in Memorizing Various Material by the Reconstruction Method', *Psychological Review Monograph*, 1909, **10**, No. 4.

case are so small as to be negligible. In the case of senseful words, the advantage of *Method A* over *C* is very great, the two standing, for different individuals, in various ratios ranging from seven to five up to four to one. It appears in general, then, that children, as compared to adults, profit much more through the employment of recitation in learning.

However, but little reliability can be placed upon the scanty findings of these experiments. The number of subjects is too small and the quantitative results are too meager. The time of the various readings and recitations not being kept, there is some doubt whether any of the methods would show a distinct advantage with respect

TABLE XVII (from Knors)

Subjects	H Fourteen nonsense syllables. Methods			I Eighteen nonsense syllables			J Ten sense words			K Eighteen sense words		
	A	B	C	A	B	C	A	B	C	A	B	C
A	6.9	12.3		7.9	14.8		4.5		4.8	5.2		7.2
B	10.4	14.5		11.1	13.2		3.9		3.8	4.7		6.8
C	9.5	13.2		7.9	12.2		4.1		4.1	3.8		5.6
Subjects	L Fourteen nonsense syllables. Methods			M Eight nonsense syllables			N Ten sense words			O Fourteen sense words		
	A	B	C	A	B	C	A	B	C	A	B	C
a	17.9	12.2	23.7	14.1	8.9	12.9	5.7		7.3	6.5		12.5
b	11.1	10.8	29.3	9.1	11.3	12.0	4.3		10.1	5.9		19.5
c	11.1	13.3	30.7	7.8	8.7	13.1	5.0		19.2	6.1		22.4
d	10.5	13.6	19.6	10.6	9.9	11.2	6.0		11.5	7.8		17.8

to the total amount of time required to learn. Unfortunately Knors did not print all of his raw data, but from what does appear, it is clear that the variability of the performances, especially those of the children, is very great. Subject *A*, for example, in three tests of learning series of nonsense syllables by *Method A*, shows an average score of 9.0 with a P. E. of 2.2. On the whole, it would not be safe to consider Knors's results as more than suggestive.

SUMMARY OF RESULTS

Without doubt, this brief enumeration of the results of such a medley of experiments has left but a vague impression with regard to present status of the problem under consideration. Perhaps an

effort to summarize the findings will assist somewhat to a better understanding. Such an effort, however, is fraught with difficulty. When one considers the individual differences possible among the subjects, the variations in materials, in method of presentation, and in the methods of scoring and the like, it can be readily understood that direct comparison of many studies is quite out of the question. Perhaps it will be worth while, first, to review the methods of attack employed in the several studies and, by throwing the differences into relief, pave the way for a concise summary of the outstanding results that will then be presented and for an understanding of the relation of the present study to those which have gone before.

1. *Differences as regards materials.* Most of the studies have employed the method of paired associates; as material, nonsense syllables in pairs, senseful words in pairs, digits paired with nonsense syllables, and foreign words paired with the vernacular have been used. Single series of senseless or senseful words of various lengths have also been used, and, in some cases, connected sense material such as prose or poetry. It is possible that the results might differ considerably according to the kind of material used; in fact, Kühn and Knors found that this was decidedly the case.

2. *Subjects.* With the exception of the few experiments with four boys, conducted by Knors, well educated adults have been employed. In nearly every case, moreover, the number of subjects has been entirely too small to eliminate differences which might be due to the influence of previously acquired habits of study as well as the more innate differences such as those considered by Miss Abbott.

3. *Methods of presenting the material.* In most cases, the material has been presented visually, but as was noted above (p. 5) sometimes the method of presentation changes within the lesson. Both Witasek and Katzaroff presented their material visually when the subject was reading, but during the recitation the material was presented orally. In some cases, the material is printed large, in some, small; in some it is held in the hand; in others, it is at a distance or thrown on a screen; sometimes the material is presented simultaneously, sometimes serially. The tempo of presentation is an important matter also. In nearly all cases, the tempo was controlled and varies greatly from experimenter to experimenter. Kühn presented syllables at the rate of one each 0.4 second, Abbott one per second, and Katzaroff one every two seconds. No one knows how closely these rates corresponded to the habitual tempo of the learner, and, what is more, as was shown by Kühn and as we shall see again later, the natural tempo of recitation is considerably

slower, on the average, than that of reading. In short, the results are affected somewhat by the rate of presentation, influence of which is likely to be different upon reading than upon recitation.

4. *Methods of reciting or recalling.* Aside from employing a fixed rate of presentation of the material, the recitation or recall often worked under other restrictions. For example, Miss Abbott in some tests restricted the learning to mere inner visualization of the data. In other cases, Knors for example, the subject was required to read and recite aloud. As a result of these various controls, the methods of learning became highly artificial; seldom was a subject permitted to study in the manner that he would spontaneously adopt, and too often the restrictions were not the same for recitation as for reading.

5. *Testing the learning and computing the results.* Sometimes the lesson consisted of a certain number of repetitions, in which cases the learning was never complete. The success attained might be measured by the rate of the next recitation following immediately or after an hour (Witasek), or simply by the amount of material that could then be reproduced immediately or after an interval, or by the time required to complete the learning then or later. Sometimes, a certain amount of time was given for study, and the amount that could be reproduced immediately or after an interval (Abbott) was taken as a measure of the learning. Sometimes, the assignment was learned at a sitting (Kühn), the score being based on the time or repetitions required to learn. Other things, such as the number of prompts required (Witasek), or the recitation time (Katzaroff), have been introduced as a measure of success. Add to these differences the highly ingenious yet anything but clean-cut methods of computation, such as those introduced by Witasek and Knors, and it is clear that to adequately compare the results of these studies one with another, is next to impossible.

Certain other sources of error, such as neglect of practice effects, fatigue, diurnal variations in efficiency add to the uncertainty. So it is only with all these differences and sources of error in mind that an attempt will be made to give a brief summary of the general status of the problem.

First. A predominance of evidence points to a greater effectiveness of recitation, compared to reading, as a factor in learning in the case of adults, at least.

Second. This rule holds true only after the learning has advanced somewhat by virtue of preliminary readings, but the exact point at which it is best to introduce recitation into the learning, or the optimum distribution of readings and recitations within the lesson, has not been satisfactorily demonstrated.

Third. The more reliable experiments, such as those of Kühn, indicate that the advantage of recitation over reading is greater in learning senseless, non-connected material than in learning senseful, connected material.

Fourth. The matter of the relative value of recitations grouped, as compared to recitations interspersed with the readings, is still an open question.

Fifth. No satisfactory evidence is at hand indicating that the general results found for adults will hold in the case of children of grammar or high school age and training.

Sixth. A considerable, but not thoroughly convincing amount of evidence indicates that the efficacy of the two methods of study depends entirely upon the learning or imagery type of the individual.

Seventh. The two broad functions, learning by reading and learning by recitation, have not as yet been adequately analyzed into their constituent functions.

III

THE SUBJECTS, MATERIALS, AND METHODS OF PROCEDURE

As was mentioned earlier, the present study was devised to answer a practical question of the school-room—namely, What are the relative values of learning by reading as compared to learning by recitation in the case of school children working under school conditions and with the ordinary school-room methods of attack? So far as practicable, everything was done to secure normal conditions for the work. The details concerning subjects, materials, methods of study, and computation of results will now be considered.

Experiments were conducted with adult subjects as well, the data from which will be used for comparative purposes and for purposes of determining more exactly the functions operative in the two methods of study. For the sake of convenience, the experiments upon adults will be described in a later section where the results are presented.

The Subjects

The subjects used were pupils of a grammar school of Oakland, California. The members of the first, fourth, sixth, and eighth grades acted as subjects for the experiments in which the nonsense syllables were used, and the third, fourth, fifth, sixth, and eighth grades for the tests with sense material. Each class consisted of from forty to forty-five pupils.

The school in which the experiments were conducted is situated in a residential suburb of Oakland and draws its pupils from the homes of business men and artisans of moderate means. In general the school stands in the first class.

As will be explained later in detail, the pupils were grouped by grades rather than by age for the tests. The following table summarizes the distribution of the members of the several grades according to age.

Materials Used

The materials were of two sorts, senseless, non-connected material and connected, sense material in the form of biographies. The nonsense syllables were constructed in a manner similar to that of

Age in years	6	7	8	9	10	11	12	13	14	15	16	17
Grade 1	24	13	4									
Grade 3		1	11	21	8	1						
Grade 4			5	16	11	4	1					
Grade 5				4	17	12	4	1	1			
Grade 6					2	7	13	9	2	1	1	1
Grade 8							1	8	13	12	7	

Müller and Schumann.[1] The sense material was constructed by the writer from material found in J. McKeen Cattell's *American Men of Science* and *Who's Who in America*. Samples are appended. While this material is senseful and connected, the organization of different parts of the whole is not so complete and systematic as would be generally found in poetry or prose, in which the ideas are more closely related and the material more closely unified by rhythms, accents, and natural pauses. This biographical form of material was used because it was desirable to approximate the kind of material that the pupils were accustomed to study in their regular history, geography, or grammar lessons.

The nonsense syllables were mimeographed in vertical columns on cards and were handed out one to each student. The sense material was mimeographed on sheets which were likewise distributed to the pupils.

Preliminary tests were conducted in order to determine the amount and difficulty of the material to include in the lesson as well as to give the subjects some preliminary practice in the tests before the actual experimentation began. The kind and amount of material was arranged so that the lesson was somewhat too large for the best students to master in the time allotted.

In the case of nonsense syllables, the series contained for the eighth grade sixteen syllables; for the sixth, fifteen; and for the fourth, fourteen. The pupils of the first grade were unable to read or write these syllables, so the teacher kindly constructed series of twelve syllables of a kind they were accustomed to manipulating, such as *ad*, *en*, *ig*, *op*, *ot*, etc. These syllables were written with a black crayon by the teacher on large strips of heavy paper.

The sense material was also arranged to suit the capacities of the different classes. For the eighth grade the biographies of five men served as a lesson; for the sixth and fifth grades, the same biographies for but four men were used. For the fourth grade easier biographies of four boys were used; while for the third grade, the biographies of three boys sufficed. Samples of the material are appended.

[1] Described by Meumann in *The Psychology of Learning*, pp. 365–368.

The following is a sample of the material used by the fifth, sixth, and eighth grades:

JAMES CHURCH, born in Michigan, February 15, 1869. Studied in Munich, and later studied Forestry and Agriculture. Director of Mt. Rose Weather Observatory in 1906. Studied evaporation of snow, water content, and frost.

JOHN CLARK, born in Indiana, June 4, 1867. Studied Surgery and became a doctor in Philadelphia. Taught at Johns Hopkins. Has visited Italy and Russia. Has a brother in Vancouver.

MORTON CLOVER, born in Ohio, April 25, 1875. Studied Chemistry at Michigan. Worked in Manila for eight years. Wrote articles on the content of dogwood, of sugar, and acids. Now lives in Detroit.

CLARENCE CORY, born in Indiana, September 4, 1872. Studied in Purdue and Cornell Universities. Now lives in Berkeley. Is Professor of Engineering and Dean of Mechanics. Since 1901 has been Consulting Engineer of San Francisco. Is a member of the British Institute.

GEORGE CURTIS, born in Massachusetts, July 10, 1872. Studied at Harvard on Geography. Won Gold Medals at Paris in 1900. Member of Boston Scientific Society. Went on the Dixie Expedition in 1902.

The following is a sample of the material used by the third and fourth grades:

HARRY, is 14 years old. His father is a farmer. Around the farm are red stones, black-berry bushes, red clay, green clover, and small trees. Harry is in the eighth grade, and is tall and slender. He likes dancing and singing.

JAMES, was born in June, 1905. He is going to be a carpenter. He can make a chair, a stool, a box, a gate, and a window. His mother has white hair and wears a black dress. His father is fifty-five years old.

HAROLD, was born in New York. He came to California when six years old. He is now fifteen years old and has a gun, a bicycle, a kite, a pair of skates, and a baseball suit. He is going to be a lawyer and live in Seattle.

FRED, was born in March, 1898. He lives on 31st and Parker Streets. He goes to business college. He is tall, has black hair and blue eyes, wears a gray suit and brown necktie. His home is made of brick and granite.

Since, as will be seen later, the same sort of tests were repeated several times, it was necessary to construct different texts equal in number to the tests given.[2] An attempt was made, of course, to make the various texts of equal difficulty, but as is usually the case, they probably vary considerably. That such differences in difficulty as may exist will not invalidate the results to any considerable extent, will be made clear later.

Method of Conducting the Tests

Several very conspicuous sources of error are to be contended with in experimental work of the present sort. That such errors have found their way into the work of previous investigators on this topic, has already been pointed out. The more important sources of error are as follows:

[2] In the case of nonsense material five tests and five texts were used; in the case of sense material six tests and an equal number of texts.

(*a*) *Practice effects.* In a series of five or six practice periods of from five to ten minutes each, it would be expected that practice effects would be considerable. Some of the earlier studies have not taken this sufficiently into account.

(*b*) *Unequal difficulty of texts.* Since one individual must repeat a similar test with many different texts, any inequality in their difficulty will affect the results. Even series of nonsense syllables may differ greatly in difficulty for different individuals.

(*c*) *Individual differences.* In the case of most of the earlier investigations the subjects were so few that individual peculiarities may have played a large role.

(*d*) *Diurnal variations in efficiency and fatigue.* It is imperative that comparative experiments should be conducted at the same hour of the day with subjects as nearly as possible in the same state of physical fitness, unless some adequate estimate of these influences be introduced as a check. In this respect nearly all of the earlier investigators have been negligent.

In order to eliminate, as far as possible, the effects of such sources of error, the method described below was employed in the work.[3]

A class, consisting of forty or more pupils on the average, was divided into a number of sections or squads,[4] the number of squads, for reasons which will be evident, being made equal to the number of methods of study that were tested. Each squad thus consisted of seven or eight pupils, the personnel remaining unchanged throughout. Different texts, of as nearly equal difficulty as possible, were of necessity used. A particular squad was tested but once on a single day, and to complete the series for each squad required five or six days. The accompanying table shows in detail the manner in which the tests were conducted. The procedure was as follows: At nine a. m. of the first day, squad one was given its first test under method one,[5] using text one. Immediately after, squad two studied the same text, according to method two; then squad three worked under method three and so on. On the next day, squad three was taken out at the first hour and studied text two according to method two; at the next hour squad four worked under method three with the same text and so on. Thus the squads progressed, during the five days, through all the trials, texts, methods, and hours. The outcome, as shown under the column indicated 'Total' is that from the point of view of the methods employed, which is the only factor with which we are concerned; all other influences are balanced or neutralized.

[3] The first grade was handled as a whole and not by squads as were the others. To be taken into new surroundings under the charge of a stranger proved to be too disturbing for these little children.

[4] Five for the learning of nonsense material, six for the learning of sense material.

[5] 'Method' refers to the manner in which the material was studied, see p. 30.

Differences in practice effects are neutralized because the sum total of practice for any one method is the same as for all others. Individual differences are neutralized because each subject has studied under each method, and no one more than once. The errors arising from differences in the difficulty of the texts are avoided, because each method has to its credit one group working with each of the six texts. The influences of diurnal variations in efficiency or

	Day 1	Day 2	Day 3	Day 4	Day 5	Total[6]
Method 1	Squad 1	Squad 2	Squad 3	Squad 4	Squad 5	All squads
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	All trials
	Hour A	Hour E	Hour D	Hour C	Hour B	All hours
	Text 1	Text 2	Text 3	Text 4	Text 5	All texts
Method 2	Squad 2	Squad 3	Squad 4	Squad 5	Squad 1	All squads
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	All trials
	Hour B	Hour A	Hour E	Hour D	Hour C	All hours
	Text 1	Text 2	Text 3	Text 4	Text 5	All texts
Method 3	Squad 3	Squad 4	Squad 5	Squad 1	Squad 2	All squads
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	All trials
	Hour C	Hour B	Hour A	Hour E	Hour D	All hours
	Text 1	Text 2	Text 3	Text 4	Text 5	All texts
Method 4	Squad 4	Squad 5	Squad 1	Squad 2	Squad 3	All squads
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	All trials
	Hour D	Hour C	Hour B	Hour A	Hour E	All hours
	Text 1	Text 2	Text 3	Text 4	Text 5	All texts
Method 5	Squad 5	Squad 1	Squad 2	Squad 3	Squad 4	All squads
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	All trials
	Hour E	Hour D	Hour C	Hour B	Hour A	All hours
	Text 1	Text 2	Text 3	Text 4	Text 5	All texts

fatigue are neutralized, since each method has been tried by one squad working at each of the different hours.

Almost ideal arrangements were made for conducting the tests.[7] In a well lighted and well ventilated room about twenty-two by fourteen feet in size, a library table large enough to seat about a dozen people was provided. The situation of the room was such that practically all noise and distractions of whatever kind were avoided. Care was taken to keep the physical conditions of the room as constant and comfortable as possible. Fresh air was kept in circulation, an abundance of light was admitted, and the temperature was kept constantly between fifty-seven and sixty degrees Fahrenheit.

[6] In the case of sense material, six methods, squads, texts, etc., were used instead of five.

[7] For this I am greatly indebted to the school principal, Mr. N. Ricciardi.

Since there were but seven or eight pupils undergoing a test at a time, the experimenter who stood at the head of the table could easily keep an eye on the work of each individual. Any attempt on the part of a pupil to copy from another, to loaf, or use improper methods of any sort, could be instantly detected. Such policing was quite unnecessary and such violations of rules as did occur were in most cases unintentional. However, such factors which might result in the unreliability of the data were urgently sought, and in cases where such an unreliability was known or suspected, the entire data of that child were thrown out. In addition to the observations of the writer, the opinion of the teacher, especially with reference to doubtful cases, was sought and freely obtained. Each teacher listed the pupils in her room according to the following request, "Please list your estimates of the intelligence of the pupils in your room, in order of rank, putting the most intelligent as Number one, ——. Use your own methods of estimating and your own conception of what intelligence is. Please do not, however, make it a mere record of class standing according to grades received, and mere maturity should not be considered." The teachers also fulfilled a request to give the names "of such pupils that you think on account of feeble intelligence or inattentiveness, lack of persistence, indolence or inclination toward dishonesty in work, etc., would be unreliable subjects for experimental purposes." The teachers were consulted also in particular cases when the occasion arose.

As a result of these precautionary measures the work of a few pupils was discarded. The following were the chief factors which seemed to justify discarding a pupil's data:

First. Absence from one of the tests. In case a pupil missed one or more of the tests, his entire work was discarded. This was necessary because in succeeding tests he would be one or more stages behind in practice. The absentees on return were allowed to continue the work without being told that the data would not be used, as a precaution against creating any ill feeling among the pupils.

Second. Copying from others or using unfair methods of any sort. Intentional or unintentional disregard of rules was very rare.

Third. Lack of interest or loafing. Occasionally a pupil from lack of interest or less worthy motives, felt inclined to be balky or to 'quit' for a moment in the midst of a test. The data of such were discarded.

Fourth. Mental defectives. A few pupils were found to be markedly below the average in the test work. Consultation with the teacher confirmed the suspicion of sub-normality and the data of such were discarded, although they went through the work with the other pupils.

Fifth. Physical defectives. Bad cases of eye defects, weakness from previous illness, and school-yard accidents occasionally interfered with maximal performance to such an extent that the data were excluded.

On the whole, however, such cases were very rare and the spirit among the pupils was of the finest. A keen spirit of competition arose with reference both to an individual's own previous record and to the records of other individuals, such that in nearly every case the results were the products of the pupils' very best endeavors. The number of pupils who completed all of the tests in a satisfactory manner ranged from thirty-seven to forty-one in the various grades.

Methods of Studying

A single squad having been seated at the table in the separate room, a copy of the material was passed out face downward before each pupil, and the following instructions were given: "On each of these cards is a list of nonsense words [show a sample]. They are called nonsense words because in English they have no meaning. Now the object of the test today is to see how many of these words you can learn in a certain short time.

"We will proceed like this. I will give you two signals to start. At 'Ready' you take the card at the corner like this and at 'Go' you turn the card over and begin to study.

"Now you are going to study for a while in one way and then later you are going to study in a very different way. To begin with you are to study by reading this list of words over and over from beginning to end [illustrate]. Remember you are to read only. You should never look away from the paper; never close your eyes to see if you can say the words; in fact never say a single word unless you are actually looking at it, actually reading it. Remember you are to read through from the first to the last every time.

"After you have read the words through and through in this way for a while, I am going to give you a signal 'Recite'. When I say 'Recite' you are to hold your paper in front of you so that when you are looking straight ahead, you look over the top of it and you can see it by glancing downward a little like this. Now you are to try to say to yourselves as many of the syllables as you can without looking at the card. When you cannot remember the next word look down at your card and then go on saying as many of them as possible without looking. Glance at the card again whenever you cannot remember. Go through the list from the first word to the last in this way and continue until the word 'Time' is given. Remember you are not to look at the words unless you absolutely have to.

"When the learning period is over I am going to ask you to write as many of these words as you can."

It should be remembered that every class had received previous practice in the learning. The first grade had been given two trial tests of five minutes each, and every other grade one or two trials of eight minutes each, the data from which were not used.

Following is a table showing the absolute and relative amounts of time devoted to reading and to recitation in each method.

NONSENSE MATERIAL

Grade one

Method	Time of reading	Time of recitation	Per cent. reading	Per cent. recitation
1	5′	0′	100	0
2	4′	1′	80	20
3	3′	2′	60	40
4	2′	3′	40	60
5	1′	4′	20	80

Grades four, six, and eight

1	9′	0	100	0
2	7′12″	1′48″	80	20
3	5′24″	3′36″	60	40
4	3′36″	5′24″	40	60
5	1′48″	7′12″	20	80

SENSE MATERIAL

Grade three

Method	Time of reading	Time of recitation	Per cent. reading	Per cent. recitation
1	7′30″	0	100	0
2	6′	1′30″	80	20
3	4′30″	3′	60	40
4	3′	4′30″	40	60
5	1′30″	6′	20	80
6	45″	6′45″	10	90

Grades four, five, six, and eight

1	9′	0	100	0
2	7′12″	1′48″	80	20
3	5′24″	3′36″	60	40
4	3′36″	5′24″	40	60
5	1′48″	7′12″	20	80
6	54″	8′06″	10	90

The study period was made somewhat shorter for the first and third grades, because it was found that steady application for longer periods was quite fatiguing.

At the end of each study period the pupils promptly placed the text papers face downward and began at once to write the material upon sheets that were provided. They were instructed to give the material in the original order as far as possible. In the case of nonsense syllables, the recall was pure reproduction, but when the sense material was used, the names of the individuals whose biographies were studied were written on the board in proper order. This was the only aid that was given. Ample time was allotted in which to write the material remembered.

Three or four hours later, tests for retention were given. The test consisted in simply asking the pupils to write, as before, all the material they could remember. No aids were given except that the names, in the case of sense material, were written on the board as in the immediate test.

Notes were kept of all manifestations of the children's work such as movements of the lips, whisperings, rhythmical movements of the head, or hands or feet, tappings of the fingers, directions of the gaze, etc., in fact, of all appearances which might be of later service in interpreting the results. The judgments of the pupils were frequently called for upon such matters as the methods which they liked or disliked, why the nonsense syllables were hard to learn and the like. These will be dealt with later.

The method thus far described applies only to the work with the school children. Different methods were employed upon the adult subjects and they can most conveniently be described on a later page where the results are presented.

TREATMENT OF THE DATA

Method of scoring the nonsense syllables. The nonsense syllables were scored by giving three points for a syllable correct in form and position; two points for a syllable correct in position with one letter incorrect; two points for a syllable correct in form but not in correct position; one point for a syllable with two letters correct but in wrong position. For example:

Correct list	Reproduced list	
pib	pib	= 3
bah	dah	= 2
rem	bug	= 1
lor	rem	= 2
cug	lag	= 0

Although more exact methods of scoring nonsense syllables are available, it was thought that the additional precision that might be obtained by their use would scarcely justify the additional labor involved.

All of the nonsense syllables were scored by a person who had no acquaintance with the nature of the experiment. In order to test the personal equation as manifest in the scoring, a set of forty lists were graded by two individuals, neither being aware that the lists were to be, or had been, corrected by another. The variations were found to be very small and due to variable errors so that the averages were about the same. The average score for forty papers was for one grader 22.81, for the other 22.88. From these figures the P. E. was computed by means of the formula $\text{P. E.} = .84435 \frac{\text{A. D. dis.}}{\sqrt{n}}$ The P. E. thus determined is 0.021. The personal factor involved in the scoring of results is thus too small to be of significance.

The material of the first grade pupils (two letter syllables) was graded by simply counting the number of syllables that were correct in spelling. These children had had but little experience in writing on paper and as a consequence their syllables were mixed up so badly that it was impossible in many cases to be sure what order was intended. Consequently, correctness in form, only, was considered.

Method of scoring the sense material. The sense material was scored by dividing the original texts into details, ideas, or facts that were mentioned, to serve as a guide. One credit was given for the correct reproduction of each of these 'details' when they fell under the proper name. When a detail, such as a birthplace, was correctly reproduced but applied to the wrong person, one-half a unit was given. In some cases the credits of one-half or three-fourths were given to details or facts partly correct, depending upon the judgment of the reader.

Part of the sense material was scored by one individual and part by another, neither of whom was acquainted with the experiments in general. To test the reliability of the judgments, forty papers were scored independently by each. Variations of small magnitude but greater than for the nonsense material were found, but these were due to variable errors that compensated each other in the long run, producing on an average of forty scores very slight differences. The P. E., computed as above, is 0.015. This P. E. is so small in comparison with the P. E.'s of the averages that it has not been taken into consideration in the final computations of the results.

METHODS OF COMPUTING THE RESULTS

The results show the average scores based upon the methods of grading just mentioned. To be more accurate, the tables show a grand average of the averages of the several squads for each method of study. The work of several pupils, for various reasons that have been cited, was rejected, with the result that the final number of individuals in some squads is greater than that in others. Since, from the point of view of any particular method, the practice effects of each squad differed from every other, to permit the results of a squad to enter the final average with full weight, would distort the figures in a degree amounting to the average difference in efficiency due to the greater amount of practice of the one over the other. This overweighting was avoided by averaging each squad separately and then making an average of these figures.

For the same reason the P. E.'s could not be computed in the regular manner but must be based upon the results of the individual squads. Assuming that the averages of the several squads would be equal except for differences due to practice, fatigue, and diurnal variations, the deviations of the figures within each squad from the average of that squad were computed. A sum of the deviations for all individuals from the average of their squad was thus obtained and divided by the total number of individuals in the class, thus giving the Average Deviation. The P. E.'s were then computed according to the formula: [8]

$$\text{P. E. tr. av.} - \text{obt. av.} = 0.8453 \frac{\text{A. D. dis.}}{\sqrt{n}}$$

[8] See Thorndike, E. L., *Mental and Social Measurements*, New York, 1912, pp. 186 ff.

IV

QUANTITATIVE RESULTS

It was pointed out earlier that the amount of material given as a lesson was slightly greater than the best students could learn in the time allotted. Learning was never complete, although in the case of many individuals it was nearly so. With nonsense syllables as material, the average scores for the best methods are for different classes from fifty to seventy-three per cent. of the highest possible score. For the sense material, the best average scores are in the neighborhood of forty per cent. of the highest possible scores. This fact should be kept in mind during the consideration of the results which follow. For convenience of expression, we shall speak of 'methods' in which there was a 'combination of twenty per cent. reading with eighty per cent. recitation', etc., but it must be remembered that such expressions have a strictly local meaning, for several reasons. In the first place, such 'combinations' lead only to partial learning of the data. Perhaps the same combination would lead to very different results if applied to the time required to completely learn the lesson. A second consideration is that a 'combination' has reference only to the particular kind and the particular amount of material here used. The optimum combination would doubtless be different according to the difficulty and length of the lesson. These matters will be given more consideration on a later page.

RESULTS FOR THE LEARNING OF NONSENSE SYLLABLES BY CHILDREN

Table XVII shows the results of the immediate test for nonsense syllables in the form of average with P. E.'s computed in the manner described in the previous chapter. Table XVIII shows the same data transformed to relative scores in which the average of each class for all five methods is considered 100, serving as a basis for the other scores. The P. E.'s were changed to correspond. Figure 1 shows graphically the data of Table XVIII, the average being denoted by the heavy line, which is enclosed within two light lines representing on either side the area including the P. E.[1]

For the fourth, sixth, and eighth grades the results are clear. The results for Grade one were a disappointment and should be considered

[1] After the manner originally suggested by Professor J. McKeen Cattell.

apart from the others. The averages for this grade seem to indicate that Method Five, in which the amount of recitation is greatest, produces the poorest results while the methods involving more reading show to better advantage. The P. E.'s, however, show the averages not to be highly reliable and their significance is slight. One reason for this may lie in the fact that a less refined method was used in the case of this grade (see p. 27). In all probability, moreover, the inexperience of these beginning pupils accounts for the results in a large measure. They were simply unable to adjust themselves to

TABLE XVII

Showing the average score for each grade for the various methods of study

Method		1	2	3	4	5
Combination in mins. and secs.		L9′ R0	L7′12″ R1′48″	L5′24″ R3′36″	L3′36″ R5′24″	L1′48″ R7′12″
Combination in per cent.		L100 R0	L80 R20	L60 R40	L40 R60	L20 R80
Grade eight	Average score	16.92	23.86	25.79	27.28	35.51
	P. E.	0.61	0.69	0.65	0.66	0.86
Grade six	Average score	13.21	20.18	22.64	25.15	30.52
	P. E.	0.61	0.84	0.60	0.91	1.07
Grade four	Average score	9.45	12.00	16.10	16.95	20.03
	P. E.	0.57	0.46	0.56	0.75	0.79
Combination in mins. and secs.		L5′ R0	L4′R1′	L3′R2′	L2′R3′	L1′R4′
Combination in per cent.		L100 R0	L80 R20	L60 R40	L40 R60	L20 R80
Grade one	Average score	6.2	6.1	6.2	5.6	4.7
	P. E.	0.22	0.27	0.20	0.20	0.21

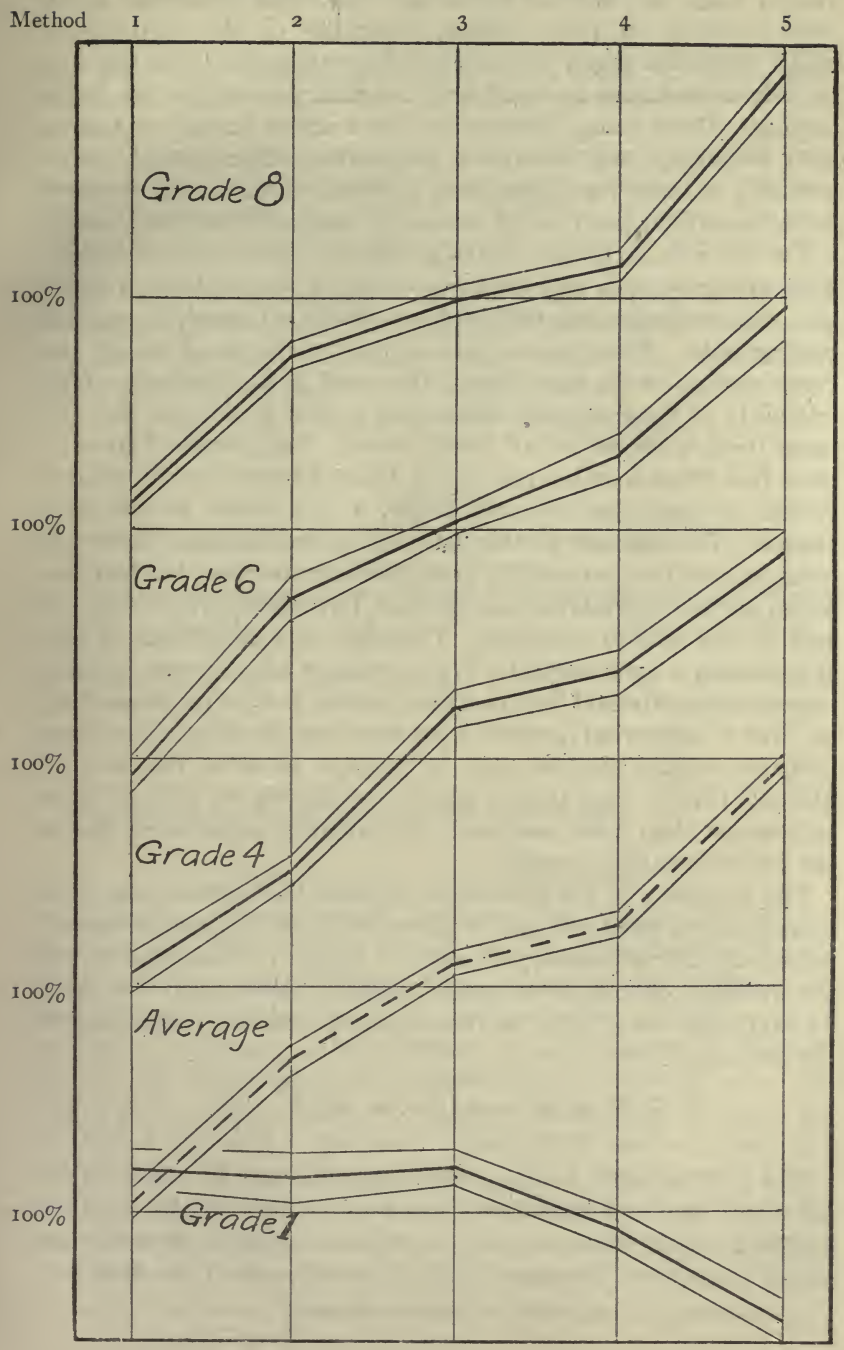
TABLE XVIII

Showing the data of Table XVII on a relative basis

Method		1	2	3	4	5
Grade eight	Relative score	65.40	92.23	99.69	105.45	137.26
	P. E.	2.37	2.69	2.53	2.57	3.35
Grade six	Relative score	59.13	88.35	101.34	112.57	136.61
	P. E.	2.74	3.78	2.70	4.09	4.81
Grade four	Relative score	63.42	80.53	108.05	113.75	134.42
	P. E.	3.42	2.76	3.36	4.50	4.74
Grade one	Relative score	107.64	105.90	107.64	97.22	81.59
	P. E.	3.80	4.67	3.46	3.46	3.63

FIGURE 1

Based on the data of Tables XVIII and XIX



the experiment. Many employed practically the same methods of study throughout, as could be seen from observation in some cases. Others made an effort to follow the prescribed directions which often resulted in poor records, especially in the methods in which recitation began very early. A great deal of time was lost in fruitless endeavor to recall syllables that were not as yet forthcoming. These young children were not skilled enough in testing their knowledge and prompting themselves where needed, which probably accounts for the apparent inferiority of the results obtained in Methods Four and Five, in which the reading periods were short.

For the fifth, sixth and eighth grades the results are convincing. The averages show a very great superiority of Method Five, in which the most recitation is introduced, over Method One which employs reading only. Twice as much is learned by the former as by the latter method in the same time. The small P. E.'s indicate a high reliability of these extreme differences, as well as the fact that the same thing is shown by all three classes. The graphs (Figure 1) show that there is an increase in the amount learned as the relative amount of recitation becomes larger, a fact shown by all three classes. The amount of this increase is not constant, however, being marked by a particularly great difference between Method One which permits no recitation and Method Two which gave twenty per cent. of the time to recitation. The effect of a minute and a half of recitation is very marked. The increase in effectiveness is fairly constant from Method Two to Three to Four, but the step from Four to Five is somewhat greater than any one of these. The most probable explanation for this exceptional score in the case of Method Five is that it was usually productive of a little more enthusiasm than other methods. The children anticipated this as the 'record breaking' method.

The reliability of the differences between the methods has been computed in a different way, as shown in Table XIX and displayed graphically by the broken line curve in Figure 1. This table shows the averages of the three grades (eighth, sixth, fifth) for each method with the P. E.'s of the averages computed according to the formula:[2]

$$\text{P. E. tr. av.} - \text{obt. av.} = .6745 \frac{\sigma \text{ dis.}}{\sqrt{n}}$$

The P. E.'s should be magnified to some extent in this table for the reason that the number of cases is very small (three) and that influence of any factor tending to create differences between the groups considered, for example, the effects of maturity or length of

[2] See Thorndike, E. L., *Mental and Social Measurements*, p. 188 ff.

school training, would make the P. E.'s larger. However, the P. E.'s are still very small.

TABLE XIX

Showing the average percentile scores with P. E.'s for Grades four, five, and eight

Method	1	2	3	4	5
Average score	62.65	87.04	103.59	110.59	136.09
P. E.	1.01	1.88	1.40	1.45	0.45

The following table shows more plainly the differences between the various methods and the P. E.'s of those differences, the computation being based on the preceding table. The formula employed for obtaining the P. E. of the differences is:[3]

$$\text{P. E. diff.} = \sqrt{(\text{P. E. av.})^2 + (\text{P. E. av.})^2}$$

TABLE XX

Showing the differences of the various methods in percentages with the P. E.'s of the differences

Differences of methods	Differences of methods	Differences of methods
2—1 = 24.39 ± P. E. 2.11	3—2 = 15.99 ± P. E. 2.34	4—3 = 7.56 ± P. E. 2.01
3—1 = 40.38 ± P. E. 1.72	4—2 = 23.55 ± P. E. 2.37	5—3 = 33.06 ± P. E. 1.47
4—1 = 47.94 ± P. E. 1.76	5—2 = 49.05 ± P. E. 1.93	5—4 = 25.50 ± P. E. 1.52
5—1 = 73.44 ± P. E. 1.10		

The differences are all conspicuous and reliable.

Differences in results among classes

A glance at Figure 1 will show that the findings for Grades four, six, and eight are very similar. In all grades Method Five is about twice as good as Method One. About the only difference is that the fourth grade does not do well, relatively, with very short periods of recitation. The difference in percentages[4] of Method Two (1′ 48″ Recitation) over Method One (all reading) is for the eighth grade 26.83 per cent., for the sixth grade 29.22 per cent., for the fourth grade 17.11 per cent. Grade four shows the slightest superiority of Method Two over Method One, but its value is rendered somewhat doubtful since the sixth grade shows a slightly greater superiority than does Grade eight. Computing the superiority of the average score from all Methods over the score of Method

[3] See Thorndike E. L., *op. cit.* [4] Based on Table XVIII.

Two, the results are: Grade eight, a superiority of 7.73 per cent.; Grade six, 11.12 per cent., and Grade four, 19.47 per cent. From these figures it appears that the older children are able to do better, relatively, with the short recitation periods.

Summary

To summarize, then, it may be stated: (*First*) that for the learning of nonsense material by children, recitation after a few initial readings is of much greater value than continued readings. (*Second*) That after preliminary readings for 1′ 48″, the more quickly the attempts at recitation are introduced, the better results will be obtained. (*Third*) No conspicuous differences appear in the results for the different classes with the exception of Grade one. (*Fourth*) which for reasons mentioned on p. 27 must be treated as a distinct case.

RESULTS FOR SENSE MATERIAL

Table XXI shows the results of the immediate test for sense material in the form of average scores. Table XXII shows the same data on a relative basis in which the average score for all methods

TABLE XXI

Showing the average score for each grade for the various methods of study [5]

Method		1	2	3	4	5	6
Combination in mins. and secs.		L9 R0	L7′12″ R1′48″	L5′24″ R3′36″	L3′36″ R5′24″	L1′48″ R7′12″	L54″ R8′06″
Combination in per cent.		L100 R0	L80 R20	L60 R40	L40 R60	L20 R80	L10 R90
Grade eight	Average score	20.77	22.39	24.84	24.95	25.28	23.75
	P. E.	0.72	0.87	0.70	0.69	0.50	0.82
Grade six	Average score	15.13	16.55	18.01	17.70	17.77	16.63
	P. E.	0.75	0.59	0.69	0.68	0.82	0.68
Grade five	Average score	11.79	13 95	15 21	15.96	15.33	15.74
	P. E.	0.40	0.43	0.48	0.56	0.50	0.55
Grade four	Average score	14.61	16.91	16.36	18.81	17.62	17.20
	P. E.	0.77	0.78	0.86	0.77	0.70	0.71
Combination in mins. and secs.		L7′30″ R0	L6′ R1′30″	L4′30″ R3′	L3′ R4′30″	L1′30″ R6′	L45″ R6′45″
Combination in per cent.		L100 R0	L80 R20	L60 R40	L40 R60	L20 R80	L10 R90
Grade three	Average score	8.66	10.34	11.18	14.12	13.10	12.09
	P. E.	0.39	0.49	0.49	0.46	0.56	0.54

[5] The highest possible score, approximately, is for Grade eight, 60; for Grades six, five and four, 48; and for Grade three, 36.

for that grade equals 100. The P. E.'s are computed as described above (p. 34). Figure 2 shows graphically the data of Tables XXII and XXIII.

TABLE XXII

Showing the data of Table XXI on a relative basis

Method		1	2	3	4	5	6
Grade eight	Relative score	87.78	94.62	104.98	105.45	106.80	100.03
	P. E.	3.01	3.64	2.93	2.89	2.09	3.43
Grade six	Relative score	89.21	97.58	106.19	104.36	104.77	98.06
	P. E.	4.42	3.48	4.09	4.01	4.83	4.01
Grade five	Relative score	80.42	95.15	103.75	108.86	104.57	107.36
	P. E.	2.72	2.93	3.27	3.81	3.41	3.75
Grade four	Relative score	86.34	99.94	96.69	111.17	104.13	101.65
	P. E.	4.54	4.60	5.07	4.54	4.13	4.18
Grade three	Relative score	74.78	89.29	96.54	121.93	113.12	104.40
	P. E.	3.35	4.21	4.21	3.95	4.81	4.64

A glance will show that the results here obtained differ from those received with nonsense material. In general the advantage of reading with recitation as compared to reading alone is less great. Moreover it appears that introducing the recitation too early proves to be of no value; in fact, for the lower grades it may prove to be a positive hindrance. This point will be taken up later. All grades agree in showing reading alone to be a poor method of study, while a combination of forty per cent. reading with sixty per cent. recitation seems to give best results.

The following table (XXIII) shows the average results for all classes combined, with the P. E.; the methods of computation being the same as those previously described.

TABLE XXIII

Showing the average percentile (relative) score for all grades combined

Method	1	2	3	4	5	6
Relative score	83.71	95.32	101.63	110.35	106.67	102.30
P. E.	1.64	0.99	1.26	1.90	1.01	0.74

In the average results, Method Four seems to be distinctly superior to Method Three and possibly superior to Methods Five and Six. In

order to more accurately determine the reliability of the differences between the methods, Table XXIV was computed after the method earlier described (p. 38) using the data from Table XXIII.

TABLE XXIV

Showing the differences between the relative scores for the several methods with the P. E. of the differences

Differences of methods	Differences of methods	Differences of methods
2—1 = 12.61 ± P. E. 1.91	3—2 = 6.31 ± P. E. 1.60	4—3 = 8.72 ± P. E. 2.27
3—1 = 17.92 ± P. E. 2.06	4—2 = 15.03 ± P. E. 2.14	5—3 = 5.04 ± P. E. 1.61
4—1 = 26.64 ± P. E. 2.50	5—2 = 11.35 ± P. E. 1.41	6—3 = 0.67 ± P. E. 1.46
5—1 = 22.96 ± P. E. 1.92	6—2 = 6.98 ± P. E. 1.23	5—4 = 3.68 ± P. E. 2.15
6—1 = 18.59 ± P. E. 1.79		6—4 = 8.05 ± P. E. 2.03
		6—5 = 4.37 ± P. E. 1.25

This table shows, that for the average results, every method is clearly superior to Method One (all reading), the smallest difference, that between Methods Two and One, being more than six times the P. E.[6] It is also certain that every method except Method One is superior to Method Two, the smallest superiority being four times the P. E. The difference between Method Three and Four is also quite reliable, being four times the P. E. The superiority of Method Five over Method Three is more than three times the P. E.; while there is no real difference between Methods Six and Three. There is no evidence that Method Four is superior to Method Five, but Four is superior to Six, and Five is also superior to Six by small but reliable differences.

We are safe in concluding then, that in general, Method One, which includes no recitation, is the poorest method, while Method Four or Five is the best. Method Two is considerably superior to Method One and Method Three is better than Two. That is to say, the best results are obtained when the recitation is introduced after one and one-half to three and one-half minutes of preliminary reading. Beginning earlier or later than this leads to poorer results.

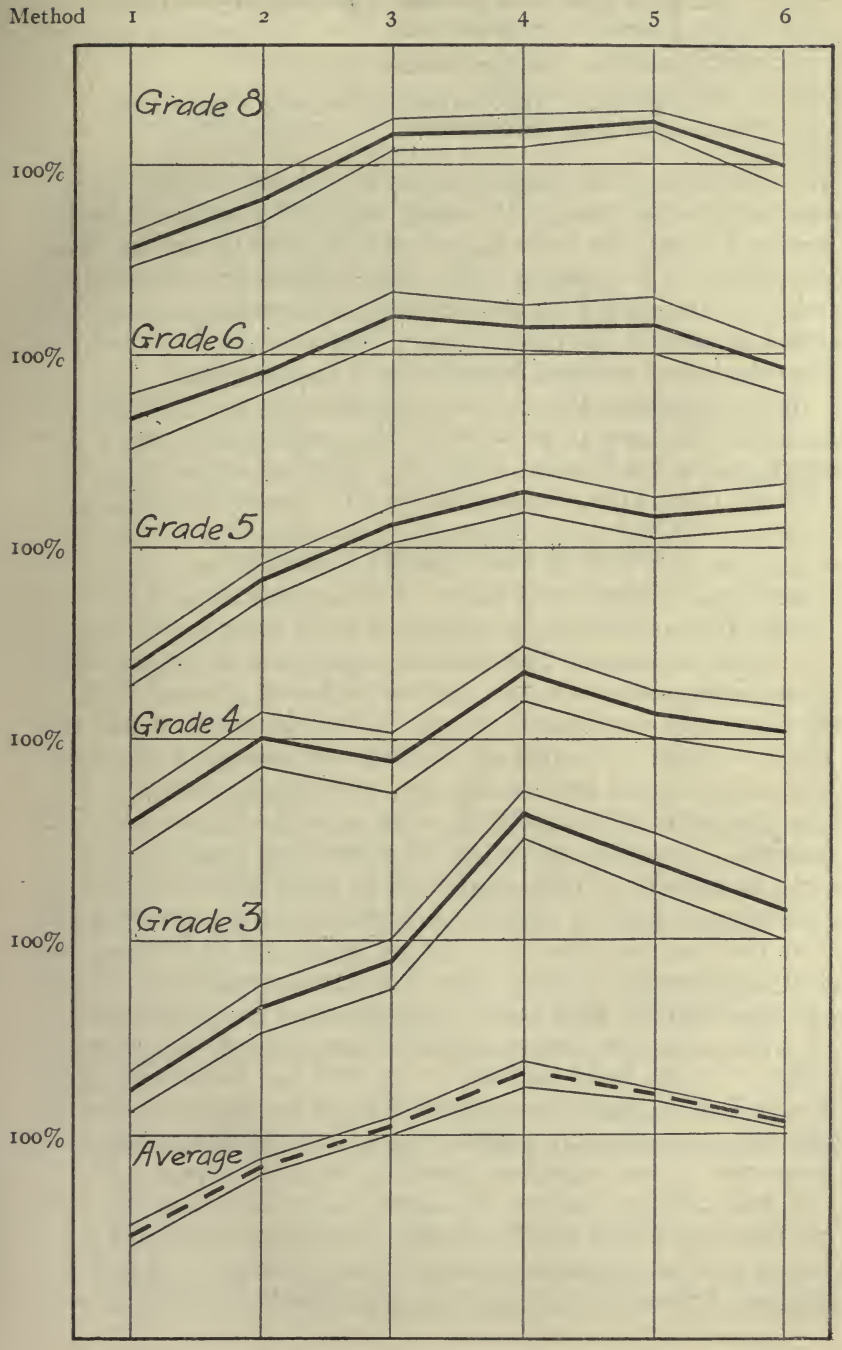
Differences in results among the classes

Such are the findings in general, but it was noted earlier that the classes differ in certain respects. These differences appear quite clearly in Figure 2. In the first place, the difference between the

[6] It should be repeated that the P. E. should be very large for the reason that all the apparent differences in the curves for the various classes (see Figure 2) result in attenuation of the P. E.

FIGURE 2

Based on the data of Tables XXII and XXIII



best and the poorest method is greater for the lower grades. *The superiority of the best over the poorest method is:*

For grade eight	19.02 per cent.	Average for 8 + 6 = 18.00
For grade six	16.98 per cent.	
For grade five	28.44 per cent.	
For grade four	24.83 per cent.	Average for 3 + 4 = 35.99
For grade three	47.15 per cent.	

The differences do not increase uniformly with the grades, but if we average the differences for the eighth and sixth grades, also for the third and fourth, the latter figure is exactly twice the former, while the fifth grade lies midway. The older children are doubtless not so badly handicapped by the lack of an opportunity to recite; or, stated in another way, the younger children are more dependent upon the factors involved in recitation in their learning.

Another difference also appears. Optimum results may be obtained by introducing recitation earlier in the period in the case of the upper grades. For Grades five, six, and eight the differences between Methods Three, Four, Five, and Six are nil or unreliably small, but in the case of Grade four the difference between Methods Six and Four is 9.52 per cent. ± P. E. 6.08; the same difference for grade three being 17.53 per cent. ± P. E. 6.0. The introduction of the recitation period too early has a deleterious effect upon the learning of the two lower grades. The probable explanation of this difference between the grades is to be found in the better adaptation of the older or more experienced learner to the conditions of the test. When recitation is introduced too early, the younger pupils waste time and energy in fruitless endeavor to recall the material. Positive errors of recall are probably numerous also and thus retard the learning. The older pupils, on the other hand, realizing that so early an attempt at recitation would be unprofitable, continue for some time to read, or divide the repetitions between reading and recitation, reciting those few sections which can be recalled, but referring promptly to their paper when the material is not forthcoming. Another explanation is possible, but less probable, *e. g.*, that the results are due to a real difference among the classes in ability to make rapid headway in the first few minutes of study. That this is not highly probable is indicated by the fact that under optimum conditions all classes learned approximately the same proportion of their respective lessons in the given time.

A final difference is that the upper grades, in comparison with the lower, do better when recitation is not introduced until fairly late, *i. e.*, when the proportion of reading is greater. Table XXII discloses the fact that for Grades six and eight Method Three (sixty

per cent. reading) is as good as any other, but for Grades three and four, Method Three is considerably inferior to Methods Four, Five, or Six. For Grade three the superiority of Method Four over Method Three is 25.39 per cent. ± P. E. 5.65; for rade Gfour, 14.48 per cent. ± P. E. 6.70. Grade five lies between the extremes, showing a small (5.11 per cent.) but scarcely reliable superiority of Method Four over Method Three. This difference cannot easily be accounted for, precisely, with the evidence at hand. It is probably due to the greater experience of the more advanced students in learning material—history, geography, and other lessons—in which reading plays a very important part. By virtue of this experience, the older children were more skillful in employing the most fruitful methods of attack in reading which virtually amounted to less pure reading, *i. e.*, reading which was in some degree recitation. The younger children stuck more strictly to pure reading. These matters, however, must be waived to a later consideration. It is only necessary here to suggest that such class differences, whatever the explanation for them may be, are of marked pedagogical importance.

Summary of Results for Sense Material

1. In general, best results are obtained by introducing recitation after devoting about forty per cent. of the time to reading. Introducing recitation too early or too late leads to poorer results.

2. In general, the optimum combination of reading and recitation, under the conditions of the present tests, shows a superiority over reading alone by about thirty per cent.

3. The lower grades differ from the upper grades in three respects.

a. The advantage of the best combination of reading and recitation over the method of learning by reading alone is twice as great for the lower grades, the average for grades three and four being 35.99 per cent. as compared to 18.00 per cent. the average for grades six and eight.

b. Introducing recitation earlier than the stage indicated in (1) above, had a disadvantageous effect upon the learning of the lower grades, but little or no ill effect upon the work of the upper grades.

c. The upper grades, in comparison with the lower, learn more effectively under the methods involving a relatively large amount of reading.

RESULTS AS REGARDS RETENTION OF NONSENSE MATERIAL

Tests for retention of nonsense syllables were given from three to four hours after the learning period, the exact intervals varying for

different classes but being always the same for all squads of any one class. The pupils were simply asked to write down in proper order all the syllables they could remember. It is impossible to determine the unreliability of the retention results due to review, intentional or otherwise, on the part of the pupils during the interval between the learning period and the tests. That a few pupils did review the material during the interim was obvious from the fact that they obtained a higher score in the retention tests than in the immediate test. Such results were, of course, discarded. It was impossible to detect other cases in which the reviewing was less extensive. With the exception of a few suspicious cases, the results showed little or no indication of such procedure. An effort in the way of appeal from teachers and the experimenter was made to discourage such practices, and, on the whole, there are good reasons for believing the results, aside from the exceptions mentioned, are quite reliable enough for broad interpretation. It would be unwise, however, to give the data much weight for the interpretation of fine differences, such as the differences between closely related classes.

Table XXV shows the results in the form of averages with P. E.'s computed in the manner previously described. Table XXVI likewise shows the results on a relative basis.

TABLE XXV

Showing the average scores obtained in the retention tests

Method		1	2	3	4	5
Grade eight	Average score	7.02	12.55	13.66	17.55	22.89
Interval four hours	P. E.	0.42	0.78	0.57	0.67	0.88
Grade six	Average score	5.23	7.12	9.91	12.58	20.38
Interval three hours	P. E.	0.45	0.54	0.72	0.82	1.19
Grade four	Average score	3.49	5.89	8.35	10.58	14.25
Interval three hours	P. E.	0.38	0.56	0.53	0.47	0.53
Grade one	Average score	4.03	3.17	3.57	3.37	3.11
Interval three hours	P. E.	0.18	0.24	0.21	0.18	0.27

It is at once apparent that in a general way the results of the retention tests are very similar to those of the immediate test. Grade one stands by itself again for reasons that have been mentioned. Table XXVII shows the results of Grades four, six, and eight combined.

TABLE XXVI

Showing the data of Table XXV on a relative basis

Method		1	2	3	4	5
Grade eight	Relative score	47.65	85.20	92.73	119.14	155.46
	P. E.	2.85	5.30	3.87	4.55	5.98
Grade six	Relative score	47.37	64.49	89.76	113.95	184.60
	P. E.	4.07	4.88	6.51	7.42	10.76
Grade four	Relative score	41.01	69.21	98.12	124.32	167.45
	P. E.	4.44	6.55	6.20	5.49	6.20
Grade one	Relative score	116.81	91.88	103.48	97.68	90.14
	P. E.	5.22	6.96	6.09	5.22	7.83

TABLE XXVII

Method	1	2	3	4	5
Relative score—average for Grades four, six, and eight	45.34	72.96	93.53	119.13	169.17
P. E.	1.19	3.32	1.34	1.92	4.47

Table XXVIII following shows the differences between the various methods computed from Table XXVII.

TABLE XXVIII

Showing the differences between the various methods with P. E.'s of the differences

Differences of methods	Differences of methods	Differences of methods
2—1 = 27.62 ± P. E. 3.51	3—2 = 20.57 ± P. E. 3.60	4—3 = 25.60 ± P. E. 2.34
3—1 = 48.19 ± P. E. 1.78	4—2 = 46.17 ± P. E. 3.87	5—3 = 75.64 ± P. E. 4.62
4—1 = 74.79 ± P. E. 2.25	5—2 = 96.21 ± P. E. 5.56	5—4 = 50.04 ± P. E. 4.84
5—1 = 80.75 ± P. E. 4.58		

The steps from Method One to Method Five are all large and reliable. Nearly four times as much is recalled when the learning was predominantly recitation (Method Five) as when it was entirely reading (Method One). As the amount of recitation increases the amount recalled becomes greater. This increase in the amount recalled is fairly uniform with the exception of the comparatively

great difference between Methods Four and Five. An explanation for this was suggested earlier.

It will be recalled that in the immediate tests no differences were found between the performances of the grades (except Grade one) so far as the effects of the different methods of learning were concerned. In the recall tests, there seems to be a slight difference between Grades eight and five with respect to the superiority of Method Five over Method One. From Table XXVI the differences between Methods Five and One have been computed with results as follows:

Differences for grade eight is 107.81 ± P. E. 5.83
Differences for grade six is 137.23 ± P. E. 11.70
Differences for grade five is 126.44 ± P. E. 7.61

The superiority, in this respect, of Grade five over Grade eight is 18.63 per cent. ± P. E. 9.53. The P. E. of the average of Grade six is so large as to make comparisons with that grade meaningless. Although Grades eight and five do differ by twice the P. E., the exception in the case of Grade six and the possibility

TABLE XXIX

Showing the score obtained in the retention tests for sense material

Method		1	2	3	4	5	6
Grade eight	Relative score	9.59	11.60	15.29	15.77	15.51	14.53
Interval four hours	P. E.	0.37	0.50	0.46	0.54	0.47	0.59
Grade six	Relative score	8.13	8.61	12.36	13.43	12.99	11.13
Interval three hours	P. E.	0.43	0.40	0.60	0.60	0.62	0.57
Grade five	Relative score	7.17	8.20	10.51	12.28	10.79	11.62
Interval three hours	P. E.	0.27	0.29	0.39	0.44	0.36	0.39
Grade four	Relative score	7.66	9.14	9.67	11.23	10.36	9.90
Interval four hours	P. E.	0.49	0.44	0.47	0.61	0.47	0.47
Grade three	Relative score	4.75	5.83	8.16	9.40	8.89	8.70
Interval three hours	P. E.	0.36	0.39	0.41	0.43	0.44	0.34

of a more general unreliability of the data (see p. 46) for fine distinctions, casts doubt upon this apparent difference between grades.

In general, then, the results for the retention of nonsense syllables are similar to those found in immediate tests, with the important

difference that the superiority of the methods involving recitation is much greater.

RESULTS AS REGARDS RETENTION OF SENSE MATERIAL

Tests for retention of the sense material were given from three to four hours after the learning tests, the time always being the same for each class. The names of the individuals whose biographies had been studied were written on the board and the pupils were asked to write all they could remember about each person. Ample time was given.

TABLE XXX

Showing the data of Table XXIX on a relative basis

Method		1	2	3	4	5	6
Grade eight	Relative score	79.58	96.26	126.88	130.87	128.71	120.58
	P. E.	3.06	4.14	3.81	4.47	3.89	4.89
Grade six	Relative score	74.31	78.70	112.97	122.76	118.73	101.73
	P. E.	3.93	3.65	5.48	5.48	5.66	5.20
Grade five	Relative score	71.06	81.26	104.16	121.70	106.93	115.16
	P. E.	2.71	2.90	3.89	4.42	3.60	3.90
Grade four	Relative score	79.29	94.61	100.10	116.25	107.24	102.48
	P. E.	5.04	4.53	4.84	6.28	4.84	4.84
Grade three	Relative score	62.33	76.50	107.08	123.35	116.66	114.17
	P. E.	4.71	5.10	5.37	5.63	5.76	4.45

Table XXIX shows the results for the various grades in the form of averages with P. E.'s computed as before. Table XXX gives the same data on a relative basis. Figure 3 gives the data of Tables XXX and XXXI in graphic form.

TABLE XXXI

Showing the average of the results for all grades

Method	1	2	3	4	5	6
Average	73.31	85.44	110.23	122.98	115.65	110.82
P. E.	1.93	2.45	2.83	1.43	2.46	2.27

Table XXXII following shows the differences between the various methods with the P. E. of the differences, computed from the data of Table XXXI.

TABLE XXXII

Showing the differences between the various methods with the P. E. of the differences

Methods	Methods	Methods
2—1 = 12.13 ± P. E. 3.12	3—2 = 24.79 ± P. E. 3.74	4—3 = 12.75 ± P. E. 3.16
3—1 = 36.92 ± P. E. 3.42	4—2 = 37.54 ± P. E. 2.83	5—3 = 5.42 ± P. E. 3.74
4—1 = 49.67 ± P. E. 2.40	5—2 = 30.21 ± P. E. 3.46	6—3 = 0.59 ± P. E. 3.63
5—1 = 42.34 ± P. E. 3.12	6—2 = 24.38 ± P. E. 3.34	5—4 = −7.33 ± P. E. 2.84
6—1 = 37.11 ± P. E. 2.98		6—4 = −12.16 ± P. E. 2.68
		6—5 = −4.83 ± P. E. 3.34

From these tables it is clear that the general results for retention are very similar to those obtained in the immediate test. Method Four is the best, while Method One is the poorest. In the immediate test (see Table XXIV) Method Four showed a superiority over Method One of 26.64 per cent. ± P. E. 2.5 while in the retention test (see Table XXXII) the difference is 49.67 per cent. ± P. E. 2.4 or nearly twice as great. The earlier finding that Methods Five and Six are somewhat inferior to Method Four is borne out by the similar result in the retention test. On the whole the results of the immediate and the delayed tests are similar except that the differences between methods are more pronounced in the retention tests. In the immediate test Method Four was superior to Method One by 26.64 per cent. ± P. E. 2.5; while in the retention test the superiority is 49.67 per cent. ± P. E. 2.4.

Differences Among Grades

When the differences between grades are considered, the correspondence of the results for immediate and delayed memory is not so close. The finding in the immediate tests, that the difference between the best method and the poorest method was much greater for the lower grades, is not borne out by the results for retention.

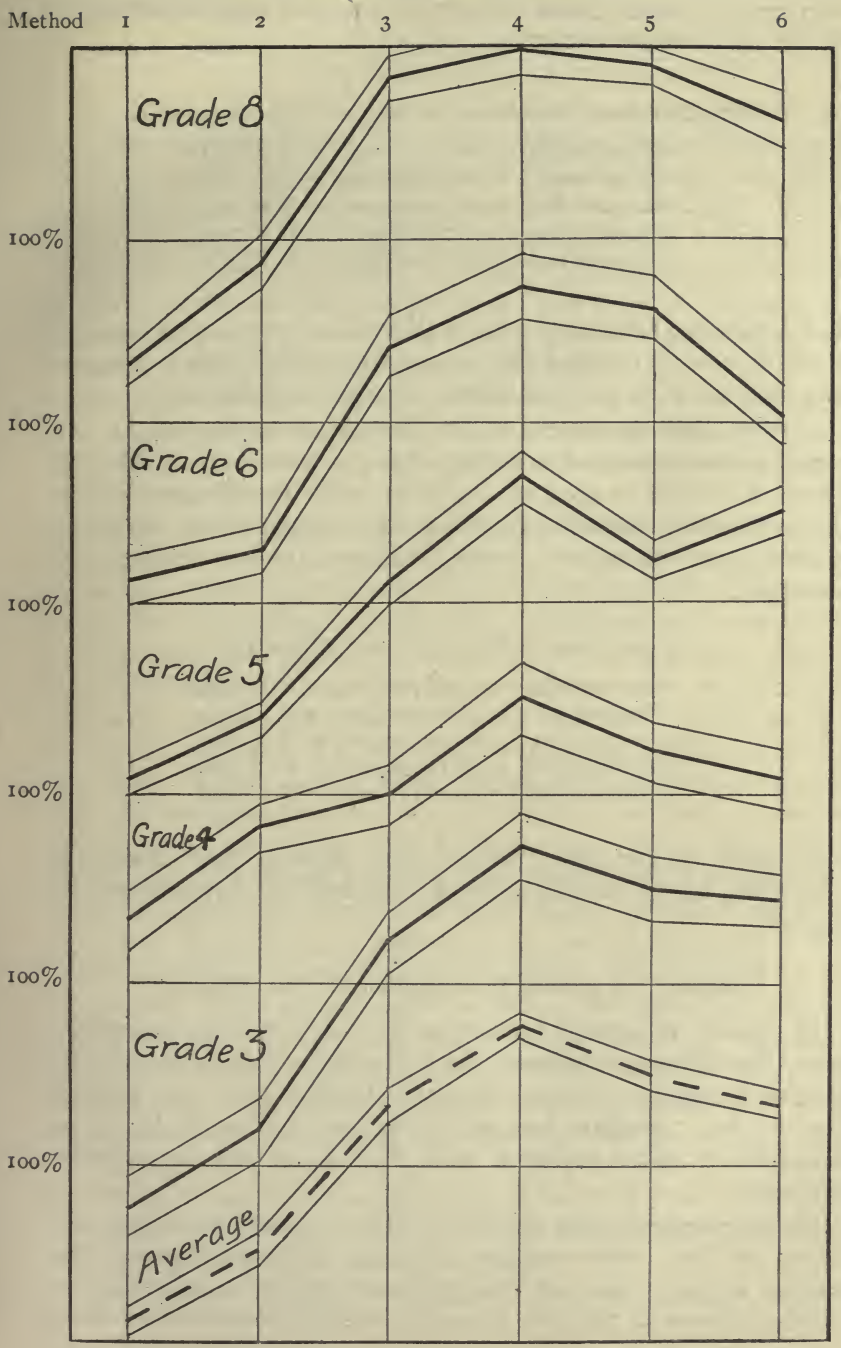
The average superiority of Method Four over Method One

For grade eight = 51.29 per cent. ± P. E. 5.38
For grade six = 48.45 per cent. ± P. E. 6.70
For grade five = 50.64 per cent. ± P. E. 5.19
For grade four = 36.96 per cent. ± P. E. 8.06
For grade three = 61.02 per cent. ± P. E. 7.28

The magnitude of these differences shows no correspondence to order of grades.

FIGURE 3

Based on the data of Tables XXX and XXXI



Another difference between grades previously found, namely, that the methods introducing recitation very early worked a hardship upon the lower grades but not on the upper ones, is not shown by the results for retention.

The superiority of Method Four over Method Six, for example, is

For grade eight = 10.29 per cent. ± P. E. 6.63
For grade six = 11.03 per cent. ± P. E. 7.55
For grade five = 6.54 per cent. ± P. E. 5.83
For grade four = 13.77 per cent. ± P. E. 7.93
For grade three = 9.18 per cent. ± P. E. 7.14

The differences between grades in this respect are nil. In fact, all of the differences between the two methods are so small in comparison with the P. E. as to be of very doubtful significance.

A third difference found on the immediate tests—that for the upper grades a method involving sixty per cent. reading (Method Three) was quite as good as any other, while for the lower grades this method was distinctly inferior to the methods giving more time to recitation—is quite clearly indicated in the findings for retention.

The superiority of Method Four over Method Three

For grade eight = 3.99 per cent. ± P. E. 5.83
For grade six = 9.79 per cent. ± P. E. 7.74
For grade five = 17.54 per cent. ± P. E. 5.83
For grade four = 16.15 per cent. ± P. E. 7.93
For grade three = 16.27 per cent. ± P. E. 7.68

For Grades six and eight, Method Four shows no real superiority over Three, but in the case of Grades five, four, three real differences appear.

Summary of Results for Retention of Sense Material

In general, the results are similar to those found for immediate tests, the differences between the best and poorest methods being somewhat greater. The superiority of Method Four over Method One in the immediate test was 26.64 per cent. ± P. E. 2.5 as compared to 49.67 per cent. ± P. E. 2.4, or very nearly twice as great.

In some respects, the findings for the retention tests have not borne out the earlier results concerning differences between the various classes. But, as was explained before, certain possible sources of error in the data from the retention tests render these

results of doubtful value for fine comparisons. The findings in the immediate tests are probably better indications of real distinctions between grades.

RESULTS FROM EXPERIMENTS UPON ADULTS WITH NONSENSE MATERIAL

In addition to the experiments carried out with children as subjects, tests were made upon adult students, using materials and methods similar in most respects to those previously described. The purpose of this extension of the work was threefold: *first*, to furnish a basis of comparison of the present results with those of earlier investigations; *second*, to permit a comparison of the work of children with adults in similar tests; and *third*, to obtain more detailed information concerning the nature of the particular functions employed in the two methods of learning.

The subjects for the tests to be described were for the most part graduate students, members of classes in experimental psychology. The materials used were qualitatively the same as those employed with the children.

Fifteen such students of psychology at Columbia were given, on three different days, ten-minute tests with series of twenty nonsense syllables. Each day one of the three different methods of study was used; *first*, 10′ reading; *second*, 5′ L + 5′ R; *third*, 2′ L + 8′ R.

The group was divided into three squads, and practice effects, individual differences and differences in tests were neutralized in the total by employing a method in all essentials the same as that described on p. 26 ff. The records of the individual students, however, are fairly reliable as such for the reason that all of these subjects had just completed a series of experiments on the learning process and memory extending over three months. Each had learned during this time several hundred nonsense syllables as well as much other material and were thus fairly highly practised subjects. Detailed introspective accounts of the factors involved in the several methods of learning were requested. These will be considered later. Each person acted as subject for his or her regular laboratory partner, who kept the time, and noted the number of repetitions made. Later the two reversed positions, the former experimenter now acting as subject. Each used a different series of syllables, and six different texts were used altogether.

The data were scored by giving a grade for each correct letter when there were two or more correct, and an additional credit when the syllable was in correct position. The highest possible score for the twenty syllables would thus be eighty.[7]

[7] See Lyon, D. O., 'The Relation of Quickness of Learning to Retentiveness', *Archives of Psychology*, 1916, No. 24, p. 27.

Table XXXIII shows the records of the various individuals with the average, the A. D.'s, for the number of repetitions and the P. E.'s for the obtained average. The P. E.'s were computed by the formula $P.E. = .6745 \frac{\sigma \text{ dis.}}{\sqrt{n}}$

The differences between the methods as shown by the average results are large and reliable, the P. E.'s being small. In general Method Three results in more than twice as much material learned

TABLE XXXIII

Showing the scores obtained by adults in learning nonsense syllables. Highest possible score eighty

Subject	Method 1. L10′		Method 2. L5′ R5′			Method 3. L2′ R8′		
	Repetitions	Score	Repetitions L	R	Score	Repetitions L	R	Score
	Day one		*Day two*			*Day three*		
Hm.	62	22	26	21	60	6	25	78
Dn.	54	32	22	18	49	5	21	80
Bm.	23	16	13	11	58	5	10	74
Bs.	22	32	15	10	60	4	9	80
Tr.	50	23	24	23	38	6	15	68
	Day two		*Day three*			*Day one*		
Py.	55	7	20	6	19	6	9	47
Gl.	68	9	17	5	40	7	13	49
Bn.	26	38	23	14	52	7	16	78
Jy.	26	28	9	7	32	6	14	42
Hr.	38	36	12	10	56	5	16	50
	Day three		*Day one*			*Day two*		
Mk.	37	24	18	14	48	6	16	60
Sn.	50	29	24	20	58	9	29	74
At.	36	56	10	8	56	4	18	63
Ly.	23	12	25	15	43	6	11	62
Wp.	29	23	10	14	30	4	15	50
Average	40	25.8	18	13	46.6	5.7	16	63.7
	A.D.14	P.E.1.2	A.D.5.2	A.D.5.1	P.E.1.4	A.D.1.0	A.D.4.0	P.E.1.4

as Method One, Method Two stands slightly above the average for the other two. Minor differences among individuals will be apparent on observation, but it will be noticed that in but one case is Method Three inferior to Method Two and in no case is Method Two inferior to Method One, although in one case Method Two is equal to and in two other cases very slightly superior to Method One. The

superiority of Method Three over the others, is somewhat greater than the data show in two cases. Subject *Bs.* had completely learned the series in 8′42″ under Method Three and Subject *Dn.* had completed the learning some time (exact amount not known) before the end of the ten-minute period.

Great individual differences appear with regard to the number of repetitions made during the ten-minute study period. The average number of repetitions when the learning was entirely by means of reading was forty, with a mean variation of fourteen. The extreme rates were those of Subject *Bs.* with twenty-two repetitions and *Gl.* with sixty-eight, or three times as many as *Bs.* Method Two shows similar individual differences in the learning by reciting as well as by reading. The average number of repetitions for five-minute reading being eighteen with a M. V. of 5.2 and for five-minute recitations the average number is thirteen with a M. V. of 5.06. The average figures also show that the rates of repetition were less for learning by reciting than for learning by reading, although as far as this test is concerned, the difference may be taken to mean merely that the repetitions in the last half of a period of learning are longer than those of the first half. That the former interpretation is more likely to be the correct one is indicated by the fact that the sum of the repetitions for the all reading test (Method One) is greater than for the half reading, half recitation test (Method Two), *i. e.*, forty as compared to thirty-one. This greater speed of repetitions in the reading portion of Method Two is shown by fourteen of the fifteen individuals. Method Three shows the same situation, the total number of repetitions here being twenty-two, with rather wide differences among individuals.

More Intensive Work with Nonsense Syllables

Somewhat more extensive work was done with two graduate students, more skilled in introspective observation. Each of these subjects was given several preliminary tests to insure an acquaintance with the procedure and to eliminate practice effects to some extent, before the main experiment was begun. Series of twenty nonsense syllables were studied for eight minutes according to six different methods. Three tests were made by each method, and in each case the number and duration of the repetition were noted by the writer who kept the time with a stop watch. But one test was made on a single day. A recall test was made after approximately six hours for Subject *S* and after twenty-four hours for Subject *T*. The following table gives the results in detail.[8] The data were

[8] The durations of the repetitions are not presented here, but will be mentioned in a later section.

scored in the manner described on p. 53, eighty being the highest score possible. The 'natural method' gave the subject liberty to study in any way he might choose.

The results for Subjects *S* and *T* are very much the same as the average results just found for the larger group. The differences between Methods Four and Five for both subjects are too small to

TABLE XXXIV

Showing the average results for three trials of each subject

Combinations	Method One 8′L		Method Two 6′L 2′R			Method Three 4′L 4′R		
	Repetitions	Score	Repetitions		Score	Repetitions		Score
	L		L	R		L	R	
Subject S, Average	17	24	8	2.3	34	6	4.3	48
Subject T, Average	32	16	9	3.0	27	13	10.0	34
Subject S, recall after six hours. Average		7.6			10.3			17.6
Subject T, recall after twenty-four hours. Average		8.6			11.3			13.3

Combinations	Method Four 2′L 6′R			Method Five 1′L 7′R			Method Six Natural Method		
	Repetitions		Score	Repetitions		Score	Repetitions		Score
	L	R		L	R		L	R	
Subject S, Average	3.5	5.6	49	2	8	52	2.6	9	51
Subject T, Average	4.0	18.0	49	3	22	51	3.0	20	50
Subject S, recall after six hours. Average			27.3			26.3			29.0
Subject T, recall after twenty-four hours. Average			22.6			24.0			21.3

be of significance and the 'natural method' produces results that are quite as good as any other. This means that trained subjects are capable of discovering and employing the best methods of attack. Subject *S* began to attempt to recite in the 'natural method' after two, four, and two repetitions respectively or at about the same stage at which recitation was begun in Methods Four or Five. The case is similar for Subject *T*. Subject *S* in Methods Four, Five, or Six learned about twice as much as in Method One,

while Subject *T* learned about three times as much. The recall tests after six or twenty-four hours bear out the findings for the learning test, being somewhat more emphatic. For Subject *S* under the optimum methods shows an amount recalled three times as great as under Method One while for Subject *T* the ratio is nearly four to one.

The speed of repetitions varies considerably for the two subjects and for the same subject at different times, but in nearly all cases reading seems to be done at a higher speed than recitation, although as will be found later the duration of repetitions during reading are very uniform while those during recitation are very irregular.

In addition to the data here presented, a few additional experiments, somewhat more specialized in nature, were performed and are presented in a later section (pp. 71 and 72), in which fourteen adult subjects participated in two five-minute periods of studying sixteen nonsense syllables, according to two methods: *first*, in which only reading was permitted; and *second*, in which recitation was permitted from the first. The average results show a score 16.4 for the reading method and 32.85 for the recitation method, or exactly twice as much. A similar test (p. 81) with eleven subjects gave similar results, 5.54 syllables being correctly recalled in the reading test as compared to 11.4 in the recitation test.

Summary of Results for Adults with Nonsense Syllables

1. Several different experiments upon adult students in learning nonsense syllables produce results similar to those found for children. The advantage of methods affording an optimum amount of recitation over the reading methods is very great, the two methods showing in general a ratio of about two to one.

2. Although considerable individual differences were found, no subject was discovered who did not obtain better results with recitation than without it.

3. Great individual differences were found in the rate at which the series were read or recited, but in general the durations of recitations are longer than the durations of readings.

4. The advantage of the methods combining recitation with reading in the learning period is more pronounced in delayed than in immediate recall.

EXPERIMENTS UPON ADULTS WITH SENSE MATERIAL

Non-connected Sense Material

Two graduate students, *S* and *T*, acted as subjects for a few tests, in studying for eight-minute periods series of thirty words of four

letters each, according to several different methods. Two preliminary trials were given in each case before the actual series were started. Two series of tests were given, the order of methods being reversed in the second series. No word was repeated in the series of lists used. The data were scored by giving a credit of two for a correct word and an additional credit if it were in the correct position. Thus the highest possible score would be ninety. Table XXXV gives the results:

TABLE XXXV

Combinations	Method one 8′ L		Method two 4′L 4′R			Method three 2′L 6′R			Method four Natural method		
	Repetitions	Score	Repetitions		Score	Repetitions		Score	Repetitions		Score
	L		L	R		L	R		L	R	
Subject S											
First series	12	30	7	4	49	3	10	53	3	11	51
Second series	15	35	6	6	58	2.5	11	60	2	11	54
Average	13.5	32.5	6.5	5	53.5	2.7	10.5	56.5	2.5	11	52.5
Subject T											
First series	14	27	8	7	39	3	14	45	3	13	50
Second series	16	34	9	7	42	3	13	47	3	15	47
Average	15	30.5	8.5	7	40.5	3	13.5	46	3	14	48.5
Subject S. Recall after six hours											
First series		15			30						20
Second series		12			17			30			
Average		13.5			23.5			30			20
Subject T. Recall after six hours											
First series		12			25						
Second series		14			29			30			
Average		13			27			30			

While this experiment is far from being extensive enough to be decisive, it is suggestive. The subjects were well habituated to this kind of learning, having previously learned nearly thirty series of nonsense syllables. Both agree in showing that lists of words can be more readily learned by a method which permits recitation, but the difference between the methods is not so pronounced as was found with nonsense syllables. For Subject *S*, in learning nonsense syllables, Method Four was related to Method One as two to one; for Subject *T* the ratio was nearly three to one; while for lists of meaningful words the ratios of the corresponding methods are for Subject *S* about one and seven-tenths to one, for Subject *T* one and five-tenths to one. The retention tests for series of words show a similar ratio, although the data are too few for reliable results.

Experiments with Connected Sense Material

Subject T endeavored in six different tests of ten minutes each to learn twenty-line stanzas of poetry from Goldsmith's 'Deserted Village', according to three different methods. Recall of the material was attempted after six hours. The results show the number of words learned or remembered.

TABLE XXXVI

Combinations	Method One 10′ L		Method Three 5′L 5′R			Method Four 2½′L 7½′R		
	Repetitions	Score	Repetitions		Score	Repetitions		Score
	L		L	R		L	R	
First series	11	78	6	4	93	3	7	84
Second series	12.5	86	5	5	106	3	8	108
Average		82			99.5			96
Recall after six hours								
First series		44			66			
Second series		53			58			58
Average		49.5			62			58

The advantage of the methods including recitation over the reading method is apparent although not very large in both the immediate and the delayed memory test. The method employing fifty per cent. reading and fifty per cent. recitation seems to be quite as good as the method permitting seventy-five per cent. recitation. The results, of course, are too few to be more than

suggestive, although they do seem to be quite in harmony with the findings for children.

The biographical sense material used with the school-children (see p. 26) was studied by fifteen graduate students under three different methods, as shown in Table XXXVII. The fifteen sub-

TABLE XXXVII

Showing the number of details or facts recalled

Combinations	Method One 8'L	Method Two 4'L 4'R	Method Three 2'L 6'R
Subjects	*Day one*	*Day two*	*Day three*
Bm	41	48	52
Ws	14	28	32
Ky	36	39	45
Tr	9	20	22
Sn	13	18	19
	Day two	*Day three*	*Day one*
At	39	47	49
Rs	40	47	39
Gl	10	20	19
Py	8	22	20
Sa	8	18	21
	Day three	*Day one*	*Day two*
Mn	14	21	26
Ce	23	27	31
An	18	24	27
Sn	19	18	21
Ms	18	30	26
Average	20.6	28.4	29.9
P. E.	2.1	1.9	1.9

jects were divided into three groups, each employing a different method on the different days. Other details were the same as those described on page 53.

The average results for Methods Two and Three are distinctly superior to those for Method One, and this is true practically without exception for all of the individual cases. The difference, in the average results, between Methods Two and Three is small and being no larger than the P. E. is unreliable. The general result of this test upon adults is the same as that obtained from the older children with the same sort of material. The value of recitation as compared to reading is not so great as it is when nonsense material is used, and no particular advantage is obtained by introducing the recitation very early in the learning.

GENERAL SUMMARY

Nonsense Material

1. In general, recitation, after a few initial readings, is of much more value in learning than more reading.

a. Under the conditions of the present experiment a method devoting the first twenty per cent. of the time to reading followed by eighty per cent. recitation will result in learning for immediate reproduction twice as much material as will a method of reading only.

b. As measured by recall three to four hours later, the difference between the two methods is about twice as great; four times as much being recalled under the recitation method as under the reading method.

2. After a certain amount of initial reading (one minute and forty-eight seconds or twenty per cent. of the total time in this experiment) the more quickly the recitation is introduced the better the results as measured by either immediate or delayed recall.

3. No conspicuous differences appear between the results for adult subjects and children or between the various grades with the exception that the findings for the first grade differ from all others.

Sense Material

1. In general the best results are obtained from a method devoting about forty per cent. of the time to reading followed by an equal amount of recitation.

2. In general, the optimum combination of reading and recitation produces in immediate tests results superior by about twenty-seven per cent. to those obtained from reading only.

a. The difference shown by recall three or four hours later is nearly twice as great as that shown in the immediate test.

3. In most respects the results for adults and for the various grades are very similar.

4. In certain respects differences between the grades were found on the basis of the results of immediate tests.

a. The advantage of the best methods over the poorest is much greater in the lower grades than in the upper, *e. g.*, the average advantage for grades three and four of the best method over the poorest is 35.99 per cent. as compared to 18 per cent., the average for Grades six and eight.

b. Introducing recitation very early in the study period has a disadvantageous effect upon the learning of the lower grades, but has little or no ill effect upon the work of the upper grades.

c. The upper grades, in comparison with the lower, learn more effectively under the methods involving a relatively large amount of reading.

5. With the exception of (*c*) above, none of the differences between grades were evident in the results of the retention tests.

a. This was believed to be due, in the main, to unavoidable errors which crept into the retention tests (see p. 46).

Results from Tests on Adults

1. The advantage of recitations over reading is greater the more senseless and unconnected the material.

a. Advantage is greatest for nonsense syllables, less great for lists of words, and still less great for connected prose or poetry.

2. Great individual differences appear in the tempo of studying by reading or recitation, some individuals completing a perusal on the average in one-third of the time taken by others.

3. As a rule, the tempo is considerably quicker in reading than in recitation, for most individuals.

4. Usually, a given individual during a single sitting, reads and rereads at a very uniform speed, while the rates for consecutive recitations are very variable.

COMPARISON WITH RESULTS OF OTHER INVESTIGATIONS

The general findings in the present experiment upon children as well as upon adults are in harmony with the results of most of the earlier investigations, which were presented in Chapter II. It will be necessary here to recall but briefly the conclusions obtained in some of the more important of the earlier works.

Katzaroff found, by combining the results for three subjects, four tests each, that fifteen readings of nonsense syllables—the test being made seventy-two hours later—produced a score of six as compared to twenty obtained from eight readings and seven recitations. Other individuals in similar tests, showed even greater differences. Witasek, Knors, and Abbott also verified the greater effectiveness of recitation in learning nonsense syllables under various conditions, although the quantitative determination of the superiority of recitation has differed considerably.

The work of Kühn, being more akin to the present experiments, is of more value for comparative purposes. In immediate tests,

the superiority of recitation over reading found by Kühn is very similar to that found in the present work, for each of the several materials used. Kühn's conclusion (p. 422), "By the majority of people [adults] recitation is much better than readings, and the relative advantage is greater, the more senseless the material," is verified by the present results with children as well as adult subjects.

With regard to the present finding that the superiority of recitation over reading is greater when measured by delayed than by immediate recall, but little evidence has been produced by the earlier studies. But the results that are available seem to be in harmony with the present findings. For example Kühn found (see p. 8) that a lesson, although learned in very much less time by means of recitation than by reading alone, was retained much better and that the superiority of recitation in this respect became greater the longer the retention test was delayed.

The matter of individual differences deserves consideration. Abbott in experiments upon five subjects found one among these for whom reading was a better method of learning than recitation and Kühn found the same in the case of three out of thirteen subjects. Both investigators found that such learners employed a 'purely mechanical' form of learning or were of very strong visual type—such that best results were obtained when the subject simply 'looks at a word and lets it soak in'. Abbott concludes, "We must go back to the type of the individual to explain the processes and relative efficiency in recall." This matter of learning types will be taken up in more detail in the next section. For the present, while there is no intention of contending that such extreme types as those found by Abbott and Kühn do not exist, the present work indicates that they are in no wise numerically so prominent as their findings would suggest. While Kühn found three among thirteen subjects, and Abbott one among five, in the present work, tests upon fifty or more adults made under less artificial conditions have not produced a single case of such 'mechanical' or 'strongly visual' types. In no case has the method of learning by reading given better results than a method in which recitation was also a factor. Unfortunately, the data of the children cannot be employed on this point with assurance, for the reason that the effects of a particular method in the case of any individual may be marked by practice effects, differences in texts, and the like. However, in spite of all these differences, an examination of the individual data shows that exceptions to the general rule that recitation is more effective than reading are very, very rare. This fact has a very important pedagogical significance, since it gives assurance that such appli-

cations as follow from a study such as the present one, may be made by the teacher to her pupils as a whole without working a hardship on more than a very few if any individuals.

Further considerations of interest to pedagogy, such as the optimum point of introducing the recitation in the case of various materials, and the efficacy of various minor functions employed in learning, will be treated in more detail in the next two sections.

V

AN ANALYSIS OF READING AND RECITATION AS FACTORS IN LEARNING

The previous section, from an objective point of view, gave us certain facts concerning two very broad and complex functions, *e. g.*, learning by reading and learning by recitation. It was found that the results, measured in terms of the amount of material learned in a given time and the amount retained after a given time, differed considerably according to the proportion of time allotted to one or the other of these two functions. One is interested to discover, if possible, in just what manner these two broad functions differ, since the result of their exercise is so markedly different. It is likely that the best method of discovering these differences is to analyse each of the complex functions, as far as possible, into their elements, finding just what minor functions are operative and in what manner they combine to make up the gross functions of learning in each case. If such an analysis can be successfully accomplished, the result should be a much better understanding of the two functions as a whole and the production of valuable suggestions with regard to the selection and combination of constituent functions for the most economical methods of study.

But such a reduction of the complex functions into constituent processes that shall be typical is by no means an easy or a certain matter. Some of the elementary functions can be observed from the outside and can be verified by objective tests, but most of the facts can be observed only by the learner and we are forced to limit ourselves to his reports upon them. Indeed, most of our analysis is of the introspective, or more accurately retrospective sort, subject to the limitations of this form of evidence.

In the present work an effort has been made to get reports as full as possible, and as free from suggestion as possible, from subjects believed to be reliable and capable. About forty subjects in all were used, and they were subjects whose experience seems to have fitted them for the retrospective work. Nearly all had had several months' practice in introspective reporting, each having learned, previous to the experiments, a large number of series of nonsense syllables and other kinds of material and having had considerable practice in describing their mental imagery in various sorts of mental tasks. After each test in the present experiments the sub-

jects wrote a full account of the functions employed in the learning, such as the kinds of imagery employed, the kinds of 'aids' used and how, their attitude toward the work, the satisfyingness and annoyingness of different methods, the fatigability of different methods, and the like. Reports from the children were secured on many of these points also. Wherever practicable the introspective accounts were checked up or tested by manipulation of the data already at hand or by new experiments devised to fit the case, and the results of other studies have been freely drawn upon.

Before proceeding to the results, a few cautions should be indicated. In the first place, individual differences play a large role. No single individual at any time is likely to make use of all the minor functions that will be described. Some subjects place more emphasis upon certain functions, some upon others, and the same individual usually changes his method to some extent according to the nature of the material and the like. More constant differences among individuals due to earlier training in learning methods or to memory types will be mentioned. But just as we found in the preceding section no very sharp differences in mental type, and no definite cases in which reading proved to be superior to recitation, so we shall find that typical methods of learning contain the main functions employed by nearly all learners.

A second caution is that wholesale conclusions from results obtained mainly from adults should not be made to apply to the learning of children. Necessarily the introspective accounts are largely those of adults, but the reports of children have also been considered to some extent, and where possible, introspective accounts have been verified by objective data obtained from children. That the minor functions employed by children should correspond closely to those of adults has already been indicated by the fact that the results of the exercise of the two general functions have been very similar for both classes of subjects.

With these precautions in mind, a consideration of the various activities, aids, and attitudes involved in learning and recalling any material will now be taken up, special attention being given to the differences that appear according to whether the method of learning is reading or recitation.

Nearly all reports, in the first place, agree in emphasizing the fact that learning even a series of sixteen or twenty nonsense syllables is far from a simple mechanical task. The number and variety of associative aids is remarkable. Where adults go to their wit's end for such associations it can hardly be doubted that they assist learning. A consideration of such aids is perhaps a good place to begin.

In general it may be said that such aids to learning may be of two sorts: one which is found in the material itself, needing only to be noted and employed, and another sort which is worked into the material by the learner. Of either sort some may be marked off as motor in character and others as perceptual.

ARTICULATION

Although the tests for learning were always written, the majority of adult subjects reported that practice in accurate pronunciation of the material was an aid in learning. This was found to be particularly true in the case of nonsense material which was difficult to articulate. Subjects report that the motor and auditory elements of the words were secured better from reciting, especially when the material offers great difficulty in pronunciation. The learner is likely to begin by carefully articulating the material to himself while reading, but if the reading is prolonged too long, these functions are likely to be neglected. In many cases the explanation given for this is that they were able to move down the series of syllables more easily without articulating, depending more upon a visual imprinting of the data. In recitation this is rarely the case. When they attempt to recite the material, the articulation is a most natural and in most cases an essential act. The reproduction and practice of the motor act is an aid to learning. The school children found considerable difficulty in pronouncing the syllables, and for them actual articulation was more essential. The members of the sixth and eighth grades in answer to the question: "Why are the syllables so hard to learn?" wrote, many of them, "Because they are hard to say." They also reported that they liked the recitation because it gave them a better chance "to see if they could say them." Movements of the lips, sometimes without, although generally with whispering, especially in the lower grades, were very marked in the recitation part of the learning period.

ACCENTS AND RHYTHMS

Articulation is usually accompanied by accenting or stressing certain syllables or words, according to the report of nearly all subjects. The following serve as samples. Subject *Rs* in one test reported accenting syllables one, five, nine, thirteen, and seventeen in the series, syllables five and nine being more strongly accented than the others. Subject *Py* accented every third syllable. Subject *Sn* accented every fourth syllable strongly and every second syllable less strongly. Subject *Bn* reported an increasing accent within groups of four syllables, the last being most strongly accented, followed by a drop to the minimum on the fifth. Sometimes these

accents are obvious to an observer who may notice the accompanying motor activities such as nodding the head, tapping the finger, or thumping the foot. That the children employ such accents was usually evident from such signs and was usually indicated by the whispering which accompanied the learning.

The value of such accents lies in the fact that a syllable comes to be associated with its accent and the act of accenting tends to call up the syllable. Although individuals show great differences in their choice of accents and the same individual may often employ different accents according to the material being studied, in any one lesson the accentuation is usually constant and assists learning through this tendency to repeat the same motor activity which acts as a frame-work upon which the syllables may be affixed.

Such accentuation should, however, be considered in connection with the almost universal employment of rhythm in the learning of a series of syllables. Müller and Schumann,[1] Meumann[2], and others have shown the value obtained from the employment of rhythm in learning. The kind of rhythm, like the kind of accentuation, varies with individuals and materials. In learning a series of twenty nonsense syllables, subject *At* divides the material into feet of three syllables, the first being long and accented, the two following unaccented and short —/ ∪ ∪ | —/ ∪ ∪ | with a pause between groups. Subject *Py* uses an identical rhythm. Subject *Sn* employs a trochaic measure with two pairs combined into a measure of four by placing greater accentuation on the third and seventh than on the first and fifth — ∪ —/ ∪ | — ∪ —/ ∪ |. Subject *Tr* employs a measure of four feet, a long accented syllable followed by three short unaccented syllables with a pause between measures, —/ ∪ ∪ ∪ | —/ ∪ ∪ ∪ |.

According to the reports of most individuals, the employment of such rhythms is the most natural thing in learning by recitation, but in reading they are not so frequently or easily used. Some report, in the case of learning by reading, that they begin by arranging the material for rhythmical perusal with accents and pauses but abandon the method before the lesson is over because it seems to be of no avail. It seemed that a method employing more visual factors and less motor would work better; their efforts were directed to 'looking hard' at the syllables to assist them to 'soak in'. Several subjects, however, reported that they did use a rhythmical division of the material throughout the reading, and their opinion that it did not prove to be of great value was usually borne out by the meagre results of the final tests. "With my eyes on the paper,"

[1] 'Experimentelle Beiträge zur Untersuchung des Gedächtnisses', *Zeitschrift für Psychologie*, 1894, 6, pp. 81–191.

[2] *The Psychology of Learning*, translated by Baird, 1913.

says subject *S*, "it is hard to do more than just read hard and think about the individual syllables. I knew the rhythms and other aids would be of more value if I could only look away from the list."

Auditory and Visual Types of Learners

It appears that there are certain differences in method according to whether the learner relies more upon auditory-motor elements or upon visual elements in learning. In some cases in which the learning is predominantly of the auditory-motor type, imprinting consists in forming a series of auditory or vocal images of the whispered words or a series of successive innervations of the vocal muscles, which are often accompanied by sensations or images of movements. The subject learns the sounds, muscular feelings, and rhythmic sequences of the syllables which he memorizes. Reproduction may be a sort of melody in which the various syllables assume their proper rhythmical positions. Usually in reproduction the subject cannot get the whole series in consciousness at once. He must start the series off and let it run its course. Now many of these subjects report that reading is of value to a certain point, but if no opportunity for recitation is afforded, the latter part of the process of learning is very much hampered and complete learning seems impossible. The presence of the words to the eye precludes the subjective innervations which are essential for learning. A different process seems to be involved when the visual stimuli are absent.

Some subjects reported that they made use of visual imagery to a much greater extent. They were not so greatly hampered by lack of recitation. But no one was found who relied entirely upon visual imprinting, auditory and motor elements being always employed as well. Of those who relied to the maximum upon visual imagery, most employed a rhythmical division of the material to some extent. Such subjects divided up the material into measures, with a motor stressing of certain syllables coupled with a visualization of all of the syllables, especially those that were accented. They differed from the auditory-motor learners, apparently, only by relying somewhat more upon visualization and less upon the auditory and motor factors. None used visual imprinting alone. In the learning by reading these subjects employed the visual factors to the utmost, with the corresponding neglect of the auditory and motor elements. While their results, as a rule, differed less for the two methods than did those of the auditory-motor learners, in no case were they so efficient in tests permitting no recitation as in the tests in which recall was a factor.

Just as there was, among about forty different adult subjects, none that could be called a purely visual learner, so there was none that seemed to rely entirely upon auditory-motor factors. Visualization to some extent usually entered into the learning of the latter. The differences were merely those of emphasis upon one or another factor, and, indeed, among the subjects were many who seemed to be able to employ now some factors, now others, according to the situation to be met. In general, learning by reading seemed to throw the emphasis upon the visual method.

LOCALIZATION AND NOTING OF POSITIONS OF ITEMS

A number of aids to memorizing which are more of a perceptual than a motor sort are usually employed. They are closely connected with the motor aids of articulation, rhythm, etc. Some of these depend upon peculiarities or divisions found in the material itself, while others are worked into it by the subject.

One important matter is the noting of the positions of certain syllables. Such localizations seem always to be an aid to memory. Sometimes localization is greatly aided by peculiarities within the text, but often more arbitrary methods of obtaining a localization schema are employed. Some report that they simply localize a certain few 'head-liners' in the series by noting their positions in visual space. Although they are not able to visualize all of the items, a few are made to stand out plainly, serving as landmarks to which others are attached. Other subjects divide the list into a certain number of parts, a few syllables thus being denoted by their numerical positions. A few report these localizations to be determined by modulation of the voice or dependent upon the rhythm that is employed. *But all report that these localizations are an aid in memorizing and that they were more easily employed in recitation than in reading.* On the introspective side such reports as these are found: (subject *T*) "In reading it was so easy to glide through the series that I did not take the trouble to note any special points of interest. It seemed that I could do more if I just looked hard at the syllables, covering up my ears so that I could do nothing but look. But when I began to recite I found that I had to note certain syllables specially, which I afterwards used as starting and stopping places." Evidently, recitation tests the value of the different aids and generally leads the learner to recognize the value of those which serve the purpose desired.

In order to obtain some objective data on the matter of localization, a test was given for that purpose. Fourteen graduate students whose status and introspective training have been described, acted

as subjects. Lists of sixteen nonsense syllables were used as material. All the subjects studied at the same time, half of them by the reading method first and half by the recitation method first. Later another experiment was given in which each used the other method. Five minutes were devoted to the study and the syllables were written down immediately afterwards. The subjects were then asked to indicate those whose positions they felt certain were correct, those which were doubtful, and those which they were sure were incorrect in position. They were then asked to describe the means or cues by which they made their judgments. The results are shown in Table XXXVIII.

It should first of all be noted that almost exactly twice as high a score was obtained by the recitation method, and this introduces a factor which tends to produce a better showing in the matter of accurate localization for the reading method. It will be noticed, for example, that many subjects in the reading series were certain of the positions of only two or three syllables, which were in nearly every case the first, or the first and second, and the last. It is well known that the first and last syllables are the easiest to learn and to localize. In the reading series these two or three syllables form

TABLE XXXVIII

Results given in the absolute number of syllables

Subject	Reading					
	Judged			Really		
	Correct	Doubtful	Wrong	Correct	Wrong	Score
Ln.	2	2	0	1	3	7
Sa.	3	2	0	2	3	13
Sn.	3	4	1	4	4	17
Ms.	2	1	2	2	3	13
J. M.	7	2	0	6	3	19
Tr.	3	2	1	2	4	11
Wr.	2	2	2	3	3	10
Ce.	4	2	1	5	2	16
Py.	9	0	0	5	4	21
Gl.	4	4	0	3	5	14
Mn.	6	4	0	7	3	23
An.	6	3	0	4	5	18
At.	11	2	0	9	4	32
Rs.	6	2	0	5	3	16
Average	4.85	2.79	0.50	4.14	3.5	16.4
Per cent.	59.6	34.3	6.3	54.2	45.8	

TABLE XXXVIII—*Continued*

Subject	Recitation					
	Judged			Really		
	Correct	Doubtful	Wrong	Correct	Wrong	Score
Ln.	6	1	3	4	0	26
Sa.	7	1	0	8	0	24
Sn.	16	0	0	16	0	48
Ms.	7	3	0	10	0	23
J. M.	8	1	2	8	3	30
Tr.	13	2	0	14	1	46
Wr.	4	5	0	4	5	24
Ce.	12	2	0	13	1	42
Py.	8	0.	0	8	0	24
Gl.	10	0	0	10	0	30
Mn.	8	2	0	8	2	26
An.	7	2	0	7	2	25
At.	15	0	0	15	0	44
Rs.	16	0	0	16	0	48
Average	9.64	1.34	0.34	10.07	1.0	32.85
Per cent.	85.1	11.8	3.1	90.9	9.1	

a larger portion of the whole number written down than in the recitation series.

In spite of this advantage, the subjects, after learning by reading, felt certain of the positions of but fifty-nine and six-tenths per cent. of the syllables written down, as compared to eighty-five and one-tenth per cent. in the recitation series. The reading series is conspicuous with respect to the number of 'doubtful' cases, which amount to thirty-four and three-tenths per cent. as compared to eleven and eight-tenths per cent. for the recitation series, or three to one. So it is quite clear that the subjects are more confident of their opinions in the recitation series. The data also show that a much larger number of the syllables learned by recitation are in correct position (ninety-one per cent.) than in the reading series (fifty-four per cent.). Another important fact appears, namely, that the judgments after learning by recitation are not only more accurate but also more conservative than after learning by reading. As to the first point, while fifty-nine and six-tenths per cent. of the syllables written down after learning by reading were judged to be in correct position, only fifty-four and two-tenths per cent. actually were, while in the recitation series, of those written a larger percentage (eighty-five and one-tenth) was judged to be in correct

position, and a still larger percentage (ninety and nine-tenths) actually was. An examination of the original data showed that in the reading series, of those judged 'doubtful' nearly all were really in an incorrect position, as were also nine of the sixty-eight certified as 'correct' in position, while in the recitation series some of those judged 'doubtful' were really in a correct position, while only two cases out of the total of 127 judgments of 'correct in position' were wrong. It thus appears that after learning by recitation, the subjects are both more accurate and more conservative in their judgments.

NOTING UNUSUAL CHARACTERISTICS OF THE MATERIAL

The remark was just made that the noting of unusual words and characteristics in the material was often an aid in localization. This function is of value because it serves to break up the material into units that can be more easily handled. A peculiar word or syllable becomes a center around which other syllables are grouped, or it may serve as a starting and stopping place within the series.

The kinds of peculiarities noted are myriad. Sometimes it is the sound—the children especially are attracted by 'funny sounding' syllables. Sometimes a syllable stands apart by having the consonants each standing above or below the line, *e. g.*, *gop*, *lib*. Sometimes the fact that one letter was printed light, or that the whole was blotched or blurred, or that a mark appeared on the page opposite it, is noted. More often the associations are meaningful, and these will be considered more fully in the next section.

Subjects report that all such peculiarities are brought out more clearly by reciting the material. They are not so effectively brought into play when one is reading because the words before the eyes render such aid unnecessary. The thing to do is simply to 'look hard and try to avoid distractions'. Subject *Fx* reports: "After the reading period was over [four minutes out of eight], I could remember only three syllables. I had a hazy idea of some of the others but I couldn't quite get them. But by picking out two queer looking syllables, the sixth and the tenth, I was soon able to fill in those between."

MEANINGS OF TERMS AND RELATIONS OF PARTS

Subjects report that the nonsense syllables take on more meaning during recitation. Some feel that in merely reading they take the syllable as it stands; they may notice its form and position but they do not try so hard to make it mean something. The meanings come out more clearly when they are forced to reconstruct it in recall. The kinds of meanings are various. Sometimes it is a far-

fetched resemblance to some familiar word, such as *toq* = *toque*, *soy* = *say*, etc. Sometimes two words are combined to form a single word, such as *sor-dit* = *sordid*, *jor-kih* = *jerky*. Often a resemblance to a familiar foreign word is seized upon, *qos* = Latin *quos*, or a word is associated with a foreign equivalent, *dit* = French 'he says'. Again a syllable is employed as part of some familiar word, as *gov* in governor, and still more common were associations between the syllables and the 'nicknames' of known persons. Sometimes the recurrence of words having a similar look or sound is noted, such as *toq* and *doc*, and occasionally the first letters of successive syllables are combined to form a new word. Sometimes the associations are less definite; the syllable merely feels big, or dull, or bright, or buzzy, *e. g.*, *viz* feels 'buzzy', likewise *zop; dit* is short and snappy, *qos* seems to be 'such a mouth full'.

In the case of sense material, recitation leads to a more thorough understanding, both of the minor details and of the meaning of the thing as a whole. They size up the men described more definitely. One subject reports, "In reading I was dealing more with a lot of details, which I handled mostly in a verbal way. There was no flesh and blood about the men. But during recitation, I could really picture them as men of [such and such age, size, etc.]." It appears that this better grasp of the meaning of the material is an aid to memory. In this connection Meumann writes:[3] "In the case of coherent and meaningful material the chief memorial support consists in the apprehension of the meaning and the logical context."

CHANGING METHODS DURING A STUDY PERIOD

A few subjects reported that they believed one advantage of recitation was to be found in the fact that they could shift from one kind of imagery to another more readily. In reading they were more likely to depend on visual imagery, or, as they reported, to use no imagery at all, but simply look at the syllables, while in recitation they would employ now one sort of imagery, now another, or more accurately emphasize different sorts of imagery at different times. One subject reports: "Sometimes I tried to recall by seeing the words in my mind's eye, and sometimes by trying to remember how it sounded, and again by trying to say several words quickly without imagery. I think this helped since it made the work more interesting and allowed me to resort to different methods when I got stuck." This shifting from one method to another may have made the work more absorbing, but its general value as an aid in

[3] *The Psychology of Learning*, p. 297.

learning may well be doubted. At all events, the greater freedom to employ any method that seems desirable is a notable characteristic of learning by recitation.

PATTERNS AND GROUPINGS

Closely connected with the previous finding that recitation leads to better articulation, accentuation, pauses, vocal inflections, use of melody and rhythms, as well as to better localization, noting of peculiarities and meanings in the material, is the finding that recitation tends more toward a division and grouping of the material. In reading, the syllables are handled more as isolated terms; the learner tries to imprint each by itself. In recitation more of an attempt is made to make the material over into some sort of pattern, a more or less highly organized structure. The patterns differ greatly among individuals and vary according to the list of syllables used. Very often the structure is decidedly of a rhythmic character, associations being formed between accented terms, their positions and pauses, as we have seen. In these cases the associations between members of a given foot are particularly strong, and the feet, although they are in the beginning relatively independent, are bound together in various ways. Sometimes the groups are of unequal length, being determined by the location of syllables which for various reasons stand out prominently. More often, of course, the groups are of equal size, including from two to six syllables, usually three or four.

Subjects report that this active process of dividing up the material and making it over into groups is more easily done in recitation. It is, however, very often done in reading also, but it is then more difficult to do; the divisions cannot be made so sharply, and the ease of reading down the series defeats their purpose. For example, one subject (*Bn*) whose results were very poor in the reading tests, said: "A certain amount of reading is valuable to get acquainted with the material and to frame up a method of attack, but thereafter it seems to do me no good. I simply can't learn by more reading, except by taking a small bit of the series, giving it special attention at one time and later going through it very hurriedly. The desire to look away from the paper to see if I can recite the material is well nigh irresistible." This 'going through it very hurriedly', which the subject speaks of, is probable a very close approach to recitation.

It thus appears that in the reading series the material is handled more by separate items than by groups. Less effort is used to build up a structural whole—there is less organization of the material. Subjects *S* and *T* show in another way an advantage of recitation

which is dependent upon better organization of the material. The following figures give the number of seconds for each of a number of repetitions in several tests.

Subject T reading

15, 12, 11, 12, 12, 12, 14, 13, 11, 15, 16, 13, 11, 9, 15, etc.
14, 13, 10, 12, 11, 15, 14, 17, 13, 13, 17, 9, 14, 13, 11, etc.
16, 10, 12, 13, 14, 12, 11, 16, 14, 9, 11, 12, 16, 12, 11, etc.

Recitation

37, 45, 62, 20, 45, 12, 45, 36, 6, 50, 35, 4
27, 5, 47, 52, 46, 8, 31, 45, 33, 12, 6
47, 27, 53, 12, 34, 5, 34, 2, 26, 53, 35

Subject S reading

24, 24, 18, 24, 32, 22, 25, 34, 26, 30
18, 14, 16, 18, 14, 20, 25, 23, 24, 19

Recitation

82, 90, 42, 72, 12, 87, 36, 12, etc.
72, 80, 36, 8, 46, 90, 42, 6, 45

In the first place it will be noted that the rates for readings are very uniform. The subject reads and rereads in much the same way, giving as we have seen about equal attention to all syllables. But in the case of recitations, the rates of the repetitions are varied, the average rate being slower with a much higher mean variation. The subjects were able to account for this, in part at least. Usually the material was divided into groups, different ones being featured at different times. To begin with, the first group was hit hard, perhaps also the last group, with the result that these two groups were earliest learned. When these were fairly well under control, attention was given to the second group, and so the learning progressed. The variations in the total time for repetitions are due to the varied treatment of some of the groups. Usually a group was perused very slowly when it first became an object of attack and once having been fairly well mastered was passed over very rapidly, except that now and then a more lengthy and more thorough review might be given.

Of special interest and importance are the very short repetitions of four, five, six, eight, etc. seconds which occur at various intervals, being more numerous near the end of the study period. The subjects reported that these amounted to very hasty reviews of the whole series. In the beginning they served the purpose of providing a better acquaintance with the material as a whole, while later on they usually amounted to very hasty surveys of the material already learned, either with or without much attention to the unlearned syllables. They served a two-fold purpose of economizing time and of working over the lesson as a whole. In the latter capacity they served the

purpose of building up associations between the various groups of items and perfecting the organization of the whole structure.

G. E. Müller,[4] who has made an extensive study of learning methods, describes in the course of memorizing series of digits, nonsense syllables, etc., several stages in the organization and grouping of the material. With simultaneous presentation, the first stage is a 'collective apprehension' of the row of items. This stage affords opportunity to secure an acquaintance with the material generally and to observe such near-lying cues as there may be that can be employed in dividing up the material for further learning. A second stage is called 'collective successive apprehension', which consists of 'a speedy perusal of the individual members of the complexes with attention'.[5] The result is that 'the two successive members of one and the same group are bound together by associations stronger than the associations between successive members of different groups'. This is followed by a third stage, which consists of an 'inner reconstruction' of the earlier apprehended groups. Usually recitation is the chief constituent of the third stage. The subject endeavors to reproduce the material without looking at it, and this leads to the employment of the various kinds of aids that have been previously mentioned. The learner must select the bonds that are requisite to reproduction and exercise them until, once set into operation, they will run their course without external assistance. Of course, during the recitation, references may be made to the text for purposes of prompting as well as for review of material already partly learned. But the 'inner reconstruction' of the material is the important function. Kühn observed as the most serious deficiency of learning by reading the almost unavoidable tendency to neglect many of the functions which are essential to recall, functions which as a rule can operate only in voluntary recall. He writes:[6] "Therefore we come to the conclusion that recitation is better because it leads to a more fundamental, many-sided working-over ('Verarbeiten') of the material."

The typical learner, we have seen, breaks up the material into smaller groups which are dealt with as units. Similar to the present findings, Kühn noted that such manipulation of the material was more characteristic of recitation. He states: "By learning with recitation the construction of groups can be carried on more readily than through reading. Many persons say, in fact, that in really pure reading such a construction of groups is impossible."[7]

[4] 'Zur Analyse der Gedächtnistätigkeit und des Vorstellungsverlaufes', *Zeitschrift für Psychologie*, 1911, Supplementary vol. 5, pp. 253–403.

[5] *Ibid.*, p. 254.

[6] 'Über Einprägung durch Lesen und durch Rezitieren', *Zeitschrift für Psychologie*, 1914, 68, p. 443.

[7] *Ibid.*, p. 440.

The manner in which these groups are built up, the determination of their number, size, and distribution, has already been described. In general, the nature of the grouping depends upon the kind and length of the material and upon a host of peculiarities which may be found within it. Great differences are also found among different individuals and for the same individual at different times.

The value of such groupings of the material as an aid in learning has been pointed out by Müller. They are in brief:

1. Although it is impossible to grasp in one span of attention a whole list of items, the smaller groups can be utilized as units for attention, thus leading to economy of time and energy in apprehending the whole group.

2. The factor of localization comes more effectively into play. One cannot remember the positions of each member of a series of twenty nonsense syllables, but he can remember the position of four or five groups, each being treated as a unit.

3. Each group comes to have its own individuality and thus serves as a center of attack.

4. Groupings assist rhythmical and melodic perusal.

5. Groups as such are more interesting than a series of single items which the learner soon becomes familiar with, as such, and then permits attention to flag. The groups, as interesting problems to be mastered, arouse and direct attention.

When the series is quite long, it is not enough that the individual groups should be mastered, but the series of groups must be bound together by additional associations. Sometimes the localization of the groups in visual space or numerically is sufficient, but very often other associative or mnemonic aids are employed.

Our previous analysis of the learning process would fit very nicely into Müller's scheme of three stages. That the reading method should be employed to some extent in the beginning has been pointed out by Müller—in fact, the first two stages are entirely dependent upon reading. The third stage of 'inner reconstruction' is, as its name implies, primarily a stage of attempted recitation.

To limit the learner entirely to the reading method precludes the possibilities of the active stage of 'inner reconstruction' and thus greatly hampers the learning. The natural tendency of the learner to resort to this latter method of study is shown in the oft repeated statement that the desire to do so was 'well nigh irresistable' and the like. Most subjects can, to varied degrees, continue to learn by reading, but there are some, perhaps, who can advance only to a limited extent. Kühn found,[8] in fact, that after a certain number, additional readings may prove not only to be of no value for imprinting, but may be positively harmful. For example, one subject (*Got.*) required after

[8] *Op. cit.*, p. 477.

40 readings, 17 additional recitations to learn
25 readings, 9 additional recitations to learn
12 readings, 6 additional recitations to learn
2 readings, 5 additional recitations to learn

Similar results were found for three other subjects. Such tests, however, have been tried with several subjects in the present study, but in no case were such negative results found, although two subjects were found who were unable by reading alone to completely master a long series of nonsense syllables.

HELPS MORE CONSTANT AND MORE NATURAL IN RECITATION

It was pointed out earlier that recitation leads more successfully to the employment of various sorts of aids, such as modulations of the voice, rhythms, pauses, meaningful associations, and the like. An additional point very often reported is that such aids not only come into play more readily in recitation but that they are more constant. During reading, some report that they emphasize now one syllable, now another; they now use one rhythm, later another; the sight of the word suggests now one association, later another. In recitation, when once adopted, the aids are more constant. This is partly due to the fact that most learners do not like to refer to the text unless it is absolutely necessary, and since recall is entirely dependent upon the use of some association, a connection once initiated is likely to be invariably employed. During reading, since the syllable in each case is present to the eye, the previously observed association, being less essential, is not so deeply impressed; other connections, depending upon the attitude of the subject at the moment, are likely to overrule it with the result that a new association is substituted. This, in essence, is what many report: "It is hard to keep my mind on the work in reading. Different influences seem to come in continually that give the material a new look. First a syllable means one thing and later I associated it with something else." Subject *Tr* says: "I first thought of *fab* as part of *fable*, *wab* as *Weber*, etc., but it was often difficult to remember some of them because I didn't have to depend upon them." A similar situation was found in the case of many subjects by Kühn, who concluded:[9] "The helps in recitation seem to be more natural, while in reading they appear manifold and artificial."

TESTING THE LEARNING

In an earlier section, evidence was found that there was a greater certainty as to what was known when recitation was employed in the learning. This, of course, is not only true at the completion of

[9] *Op. cit.*, p. 440.

the learning but during the various stages. In addition to the objective evidence already presented (p. 71 f.) are the reports of many subjects that when they read only, they are not at all certain how much of the material is known or how well it is known. They may have a general feeling that they can recite a certain part of the material, but they cannot be sure until they have tried. The recitation, of course, constitutes the test.

One of the values of recitation is that it gives exact knowledge of the results that are being produced and serves to throw into relief the efficacy of the different aids that are being employed as a means to learning the lesson. Recitation leads more surely to the selection and repetition of the desirable bonds and to the elimination of the unfit. In other types of learning, Judd has shown that knowledge of results of practice is essential to improvement.[10] He found that practice in locating the continuation of sloped lines, part of which was concealed from the subject, produced no improvement when the results of the practice were not disclosed, but improvement immediately resulted when the subject was permitted to view briefly the results of his efforts.

In an earlier section (see p. 71 f.) it was found that recitation leads not only to better localization of the syllables but it also leads to a more accurate knowledge of the correctness of the position of syllables. In learning by recitation, out of 127 judgments of 'correct in position' but two were wrong, while in the reading series nine out of sixty-eight such judgments were wrong.

In order to find if there is a greater certainty with respect to the form of the syllables without regard to their position, another similar experiment was made. Eleven graduate students acted as subjects in two tests of five minutes each, one by the reading method and one by the recitation method. Half of the subjects took the former and half the latter test first, the order being reversed for the second test. Table XXXIX gives the results.

In the first place, a greater number of syllables are written down after the recitation test than after the reading test (twelve and two-tenths as compared to eight). The absolute number judged correct in the recitation series is about twice the number so judged in the reading series, eleven and three-tenths as compared to six syllables. Likewise, the number of syllables that were actually correct was about twice as great for the method including recitation, eleven and four-tenths as compared to five and fifty-four one-hundredths. Of the total number of syllables written down in the reading series seventy-five per cent. were judged to be correct, while in the recita-

[10] 'Practice without Knowledge of Results', *Psychology Review Monographs*, 1905, 7, pp. 185–198.

tion series ninety-two and six-tenths per cent. were judged to be correct. That is to say, there was a greater assurance of correctness when the learning involved recitation. Moreover, in the recitation tests, of those written down ninety-three and four-tenths per cent. were actually correct as compared to sixty-nine and two-tenths per cent. for the reading series, indicating again that there is less certainty about the knowledge of results during reading. It should be noted that in the reading series there is a considerable discrep-

TABLE XXXIX

Results given in number of syllables correct in form without regard to position

Subject	After five minutes reading			After five minutes recitation		
	Number written	Number judged correct	Number actually correct	Number written	Number judged correct	Number actually correct
At.	13	13	11	16	15	14.5
Rs.	8	8	6	16	16	16
Py.	9	7	7	10	9	9.5
Tr.	7	5	5	15	14	14
Gl.	8	4	5	10	10	10
Mn.	11	6	7	12	10	10
An.	8	4	5	12	11	11
E. M.	5	4	4	10	9	9
J. M.	7	6	4	11	9	10
Sn.	7	5	4	16	16	16
Sa.	5	4	3	7	6	6
Average	8.0	6.0	5.54	12.2	11.3	11.4
P. E.	1.4	1.5	1.3	2.0	2.3	2.2
Per cent. of number written		75.0	69.2		92.6	93.4
Per cent. of number judged correct			92.3			100.0

ancy between the number of syllables 'judged correct' and the number 'actually correct'; while for the recitation method these two figures are almost identical. This means that after you have studied a lesson by the recitation method you are practically certain how well you know it, but after you have studied by reading you are not only uncertain about your knowledge but your honest opinion is likely to be an overestimation of your attainment. A closer examination of the table, however, will reveal the fact that individuals differ in this respect. Under the reading method, three people correctly estimate their knowledge (*i. e.*, the number of syllables 'judged correct' equals the number 'actually correct');

five people overestimate their knowledge; while three underestimate their knowledge. Confronted by this general uncertainty of results, some subjects are likely to be very conservative in their judgments and others much less so, the general result being an overestimation of attainment.

In the case of the recitation series, eight subjects correctly estimate their knowledge, while one overestimates and two underestimate their knowledge. The sum of the differences between the number 'actually correct' and the number 'judged correct' is two syllables for the recitation series and eleven for the reading series.

On the whole then, learning by reading makes it very difficult to estimate one's attainment, while learning through recitation leads to very accurate knowledge of results. This should be thought of in connection with the fact that in our tests the amount learned by recitation is about twice as great, a fact which can only emphasize the greater accuracy in that case. Other things being equal, we should expect twice as many errors of judgment in the recitation results.

Some evidence can be obtained from the children's data to indicate a similar result. From the data of several classes was computed the total number of syllables written down, and the total number of syllables that were correct in form. From the various methods of study including recitation, certain ones were chosen in order to make practice effects, etc., balance up with the reading series. The following is a sample result, based on forty pupils of the sixth grade.

	Reading		Recitation	
	Written down	Correct	Written down	Correct
Number of syllables	7.12	4.5	11.12	9.06
Relative number	100.0	63.2	100.0	81.4

The results show a clear superiority in favor of the recitation method of learning.

A similar result was found with sense material, a sample of which follows, showing in the case of thirty-nine eighth-grade pupils the number of details of facts written and the number correct.

	Reading		Recitation	
	Written down	Correct	Written down	Correct
Number of facts	27.2	22.6	28.7	26.1
Relative number	100.0	83.1	100.0	90.9

Objective data, thus, support the introspective opinion, previously given, that one has better knowledge of results in learning by recitation and that this is an aid in learning. Some of the concrete ways in which this knowledge may be of assistance may be briefly considered.

First: There is a feeling of satisfyingness in the certainty of progress, in knowing that headway is actually being made. Conversely, it is annoying to be uncertain whether the study is bringing returns. The satisfyingness results in better attention and better application to the work, while annoyingness is distracting and hampers learning. Subject *An* gives a typical report: "It [reading] was discouraging because I did not feel that I was making much progress during the last part of it. There was no way to tell."

Second: A certain saving of energy may result from knowing what parts of the material are known and what are not known. *a*. Overlearning of certain portions may be prevented. Usually the first and last syllables are first learned and when the subject knows that these are mastered, they can be passed over hastily in subsequent perusals, a very slight amount of review being sufficient to keep them intact. Subject *Rs* says: "I saved time during recitation by skipping hurriedly over the words I already knew." *b*. An opportunity is afforded to direct special attention to those portions that are still unlearned. Subjects report that certain syllables offer special difficulty which is often not suspected until they endeavor to recite. *c*. The two factors together, easing down on familiar or learned portions and attending more intensely to unfamiliar or especially difficult portions, result in a saving of energy in the long run. It makes the work more absorbing, and also makes possible short periods of relaxation of attention or breathing spells, which may result in a rebound of energy for learning the more obstinate portions.

ERRONEOUS RECALL

It is obvious that an attempted recitation may result not only in a failure to recall a certain syllable, but it may also result in erroneous recall, neither of which could occur during reading in the strict sense. If the errors are too numerous or if they are not discovered in the case of recall, they become a harmful rather than a beneficial factor in learning. Failures to recall are very frequent in some cases in which the recitation is introduced too early, with the result that time is frequently lost in unfruitful endeavor to recall items that are not as yet sufficiently fixed in mind. Erroneous recalls, under the same conditions, are also frequent, but they seldom occur without some feeling or indication of incorrectness.

Many subjects report that they profit much by these mistakes. Noting and correcting an error helps to fix the proper item in mind; it receives better attention at that moment and will receive special attention on the next repetition. Subject *Rs* said as a sample concerning a test in which recitation was begun after five minutes' reading: "Twice I failed on *puv*, each time saying *poy* [evidently confused with *soy* which followed]. But after twice correcting it, I had it so well in mind that I will probably remember it longer than any other in the series."

In connection with the matter of unsuccessful and erroneous recall, Katzaroff pointed out, as an advantage of recitation, a kind of growing satisfyingness in the task. Successful recall is satisfying and failure is annoying. As we proceed, the proportion of satisfyingness becomes steadily greater, toning up the learner and enabling him to keep up interest and application in spite of growing fatigue. He states:[11] "The learner is active, he has to seek, he rejoices when he has found and is irritated at the syllables which evade his call. Here crowd sentiments of affection for certain syllables, of antipathy for others, which contribute to enrich the associative bonds and favor conservation and recall." One of the workers in the present study similarly said: "In reading, it is the last part of the test that is most wearisome, but in recitation, it becomes almost a pleasure as I approach a mastery of the whole bunch of words."

UNINTENTIONAL RECITATION DURING THE READING TESTS

A great many of the subjects found it difficult to resist their natural tendency to recite, during the reading series; in fact, the reading was nearly always combined with more or less recall of an unintentional, practically unavoidable sort. The effort to avoid reciting acted as a positive disturbance and source of annoyance, thus distracting attention and consuming energy to no purpose. Subject *Md* speaking of the reading method said: "Very difficult and disagreeable, because I was constantly inhibiting the tendency to test what I had been trying to learn."

SATISFYINGNESS AND ANNOYINGNESS IN READING AND RECITATION

According to the introspections of many adult subjects and the reports of many school children, one conspicuous difference between reading and recitation lies in the greater satisfyingness of the latter. That the matter of satisfyingness and annoyingness of mental work is important has been emphasized by Meumann.[12] "The emotional condition in which we find ourselves during the performance

[11] *Op. cit.*, p. 257.
[12] *The Psychology of Learning*, p. 281.

of a mental task is of profound importance for the accomplishment of the task. In general, it may be said that an emotion of pleasantness facilitates the function of memory, and that unpleasantness has a very detrimental effect upon memory." Thorndike is more cautious:[13] "No one probably doubts that interest in the exercise of a function favors improvement at it," and "such statements appeal to our common sense as probably true, though they have not been fully verified."

It shall be our purpose, first, to inquire as to what differences appear between recitation and reading as producers of satisfyingness and annoyingness, and then to consider briefly in what way or by means of what minor functions these effects are brought about.

That there is greater satisfyingness in studying by the recitation method is indicated by the witness of nearly every subject, child or adult. At the close of the experiments with the school children they were asked to state what method of learning they liked best. For ease of selection the cases considered were three: one in which they read all the time, one in which they read about half of the time, and another in which they recited nearly all the time. The following table gives the distribution of opinion.

With nonsense material

	All reading	Half and half	Mostly recitation
Grade eight	3	2	29
Grade six	2	10	27

Sense material

Grade eight	4	17	20
Grade six	2	10	28

It is clear that the children strongly preferred the methods in which recitation was included.

The reasons for their preferences are varied and not very specific. Such statements as, "It isn't such hard work," "I learn better that way," were common. Some explained their preferences as follows: "I knew I was learning them when I recited"; "I get so tired when I read"; "When I recite, it's fun to see if I can say more every time than I ever did before."

The introspective accounts of adults are even more emphatic. Among the subjects listed in Table XXXIII, fourteen reported that

[13] *Educational Psychology*, vol. II, p. 219.

Method Three (two minutes reading and eight minutes recitation) was most satisfying, one that Method Two (half and half) was most natural and satisfying, and all reported that Method One (all reading) was least so. In fact, most of them report that the last four or five minutes in the reading test were positively 'annoying', 'monotonous', 'tiresome', 'very fatiguing', etc. Subject *Hn* declared: "Without a doubt, trying to learn a series of nonsense syllables in this way is the most monotonous work I have ever done. The syllables came to have absolutely no connection or association, and the typewritten letters became, after four or five minutes, so many stupid hieroglyphics."

Many of the actual ways through which reading becomes annoying and recitation satisfying have already been indicated, and they will receive but brief mention here. *a*. There is satisfaction in the realization that progress is actually being made. We have seen earlier that this is the case during recitation. Conversely, it is annoying to be uncertain of one's progress in the learning. *b*. Recitation is satisfying because it offers the learner more freedom to employ such aids, and work with such methods, as he may desire. Reading becomes annoying because it hinders or prohibits the exercise of many of the desired functions. *c*. The facts of *a* and *b* taken together explain other sources of satisfyingness in recitation. For example, it is satisfying, as Katzaroff pointed out, to attack portions of the lesson that offer special difficulties—difficulties that are often not realized until one begins to recite. Again, the opportunity that recitation affords the learner to ease off on familiar portions, and strike hard at difficult portions, seems to be a good remedy for boredom and fatigue. *d*. Annoyingness attends the constant effort exerted by many in resisting the natural tendency to recite during the reading series.

IS THERE GREATER ACTIVITY IN RECITATION THAN IN READING?

The early investigators on this subject gave great emphasis to the conclusion that recitation, as compared to learning by reading, produced a greater activity on part of the learner, and to this greater expenditure of energy was attributed in large measure the better results obtained. For example Katzaroff says:[14] "In the readings, the subject is passive, calm, indifferent; in recitation he is active."

The introspections and observations from the present work do not lead to exactly this conclusion. The distinction seems to be one of kind rather than one of quantity. It appears that recitation does not always, in fact, does not generally result in greater activity, effort, or expenditure of energy on part of the learner, but the indica-

[14] *Op. cit.*, p. 257.

tions are that the energy is expended in a different way. Certainly the conscientious learner by the reading method is not 'calm and indifferent'. An apparent, but certainly not a real lack of activity is indicated by the already mentioned fact that many of the motor functions such as articulation, accentuation, the use of rhythm, etc., are much less prominent in reading. In the next section, however, it will be seen that the subjects declare that every internal symptom indicates that reading is more consuming of energy than recitation.

FATIGUE EFFECTS OF READING AND RECITATION

Other things being equal, we should expect, were it true that recitation results in greater activity and expenditure of energy than reading, that it would also be more fatiguing. Unfortunately, in this study, we have no indisputable measure of fatigue, but it nevertheless appears, in so far as one is able by a subjective judgment to estimate fatigue, that recitation is much less fatiguing. The findings reported in the section on the satisfyingness and annoyingness of the two methods bear strongly on this point. In so far as feelings of fatigue, boredom, monotony, and the like are indices of real fatigue, there can be no doubt that recitation is less fatiguing than learning by reading. Whether or not they are measures of *real* fatigue, they are at least very important from the point of view of work in the school-room. In the face of such statements as those following, there can be no doubt that recitation is to be preferred to learning by reading in this respect. Subject *Hn:* "Reading is the most monotonous work I have ever done." Subject *Dn:* "Reading is most fatiguing because there is no variation." Subject *Fx:* "Reading most fatiguing—monotonous—took all my energy to keep up interest." Subject *Sn:* "This method very tiresome—effort seemed to be fruitless." Subject *Mk:* "Very tiresome and disagreeable." On the other hand, learning by recitation may, as Subject *Py* said, "be almost a pleasure," or, as Subject *Mk* states, "much more satisfying," or, as Subject *Rs* says, "not so bad as reading, that's certain."

Subjects also report that the after-effects of learning by reading are greater than learning by recitation. Subject *Bn* reports: "I couldn't apply myself to work for an hour after the experiment.' Subject *T:* "I felt tired all the rest of the afternoon."

From a practical point of view, it should also be considered that the fatigue, based on the amount learned, rather than the time spent, would be relatively very much greater in the case of learning by reading. The subjects report that they are very much less fatigued by ten minutes of study by recitation than by ten minutes

study by reading, yet they have learned twice as much. If the study by reading were continued until the amount learned was equal to that learned by the recitation method, the fatiguing effects of the former would doubtless be still more marked.

SUMMARY AND CONCLUSIONS AS TO THE NATURE OF READING AND RECITATION AS FUNCTIONS IN THE LEARNING PROCESS

Our analysis of learning has shown the memorization of any material, especially of nonsense material, to be a complex process involving the formation of a host of bonds. It has appeared, moreover, that many, in fact, most of these bonds can be properly formed only by means of recitation. Our subjects have reported that it was 'difficult', 'unnatural', 'annoying', 'fatiguing', or 'impossible' to establish most of the essential bonds during reading. Efforts to learn the material by rote, to memorize it mechanically or by means of 'visual imprinting' during a series of readings proved to be futile. Memorization was possible only by means of establishing bonds between items and their pronunciation, sound, or look: between items and accents, pauses, or elements of a rhythm; between items and their position in a series; between an item and other items which it may be considered a part of, similar to, or somehow related to and the like, as well as additional bonds between characteristics of successive groups of items. We have found that it is to the formation of just these bonds that recitation leads, and that it is just these functions that it is difficult or impossible to exercise adequately during reading in its pure form. Consequently it seems to be a justifiable conclusion that complete learning is possible only by means of some form of recitation. *Pure* reading alone will scarcely enable one to completely learn a lesson which exceeds the memory span by any considerable length, yet it serves an important function in the learning process as we have seen.

The considerations of the present chapter have shown that reading and recitation are very broad functions made up of many minor ones. Economical learning consists not only in selecting and exercising those more minute functions which are essential and eliminating those that are valueless, but also in exercising them in proper sequence and each for an optimum time. It will be necessary here to review but briefly some of the essential functions, indicating to which of the two broader functions they belong and the order in which they are customarily exercised.

The first stage of the learning consists, as we have seen, in looking over the whole material with the purpose of obtaining an idea of its general make-up, noting the individual items in the group, getting the pronunciation or look or sound of the terms to some

degree, and noting outstanding 'aids' which may be employed in breaking up the material to further the learning. Much may be done in this stage to determine upon a method of attack. The length of the material, its apparent difficulty, its peculiarities, the possibilities for rhythmical division, and its ready-made associations are considered. The material may be thus perused for several times until the reader feels 'familiar' with it and a method of procedure is tentatively adopted. This stage is the reading stage, including what Müller has termed the stages of 'collective' and 'successive apprehension'. That the functions of reading are essential and satisfying here has been indicated by all introspective data.

The optimum duration of this stage depends upon many factors, such as the length and difficulty of the material, the age, training and capacity of the learner, and the like. These considerations will be taken up on a later page.

Following this stage, new functions may be introduced and the original functions may be employed in a somewhat different manner. This is the stage of recitation. It consists essentially in the final selection of the bonds requisite to recall and the exercise of these bonds until they are firmly established. What these bonds are, it was the purpose of the preceding sections of this chapter to point out. Thus it appears that memorizing is in no essential way different from any other form of learning. The bonds selected are exercised, those found to be unfit are eliminated, and new bonds are added as the case demands, the period of practice being continued until, once initiated, the series of desired responses runs off in the proper order.

Like other processes of learning memorizing may be explained in physiological terms. An adequate explanation of this sort would make the difference between the functions of reading and recitation more intelligible. The learning of a series of nonsense syllables, like the formation of any habit, involves two things: a sensori-motor response or the formation of a bond between a situation and a particular response, and a sequential connection between the various situation-response bonds in serial order.[15] The following diagrams illustrate in a very rough way, what physiological actions and changes are involved in the learning of a series of nonsense syllables or any other material.

[15] A standard treatise in English upon the physiological aspects of learning is Ladd and Woodworth, *Physiological Psychology*, New York, 1911. For an abbreviated but excellent account, see also Thorndike, E. L., *Educational Psychology*, New York 1913, vol. I, chapter XIV. The illustrations used in the present article are similar in some respects to those employed by Bair to explain the development in skill in typewriting. Compare 'The Practice Curve', *Psychological Review Monographs* 1902, No. 19, pp. 1–70.

In Figures 4, 5, and 6, S, S^1, S^2,—represent the stimuli, that is, the sight of the syllables, occurring in serial order as they would in reading. These stimuli are conducted to the sensory centers A, A^1, A^2,—, which discharge respectively into the higher centers B, B^1, B^2 —, and these cells in turn discharge into M, M^1, M^2 —, the effectors which produce the motor responses of writing or speaking the syllables.

Let us consider a case of *pure* reading; *pure* in the sense of being entirely devoid of all elements of recall, waiving for the moment

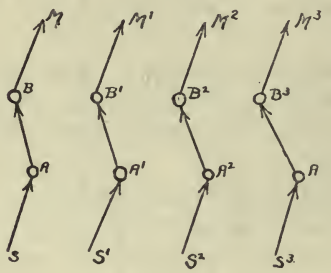


Fig. 4—'Pure' reading.

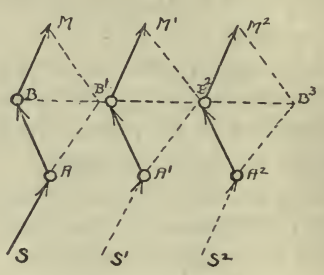


Fig. 5—Reading with formation of associations.

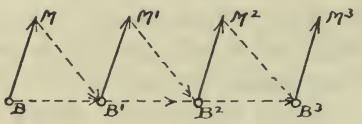


Fig. 6—Recitation.

the question of whether such reading actually exists. *Pure* reading would consist in the exercise of bonds S A B M, $S^1A^1B^1M^1$, etc., as distinct units. The more often these bonds are exercised, the more definite becomes the connections and the more automatic the response. But it is obvious that however firmly these bonds become fixed, they cannot of themselves make possible voluntary recall, since S, S^1, S^2, —, (the sight of the syllables being learned) is an essential link in the process.

Figure 6 illustrates roughly the requirements for voluntary recall. In this case the expression of the syllables (designated as M, M^1, M^2, —,) are produced in the absence of the stimuli, S, S^1, S^2, —, of the visible words. What is required here is that bonds should have been formed between the various higher units. Connections between B and B^1, M and B^1, or both, must be established. The result is that once the series is started, the physiological pro-

cesses which produce the first syllable act as the stimuli for the production of the processes which bring about the response of the second syllable and so on.

Perhaps few would doubt that this illustration would account, in a very rough way, for the process of recall, but many might be unwilling to admit that Figure 4 is a correct representation of the processes involved in reading. The doctrine of association by contiguity might insist that the mere repetition of the syllables one after another would result in the establishment of bonds between them. Bair,[16] consequent to his study of the development of skill in typewriting, concluded, although he really gave very little weight to it, that "connections are formed between cells that for a number of times have been stimulated or discharged—in succession." Woodworth has pointed out the inadequacy of this doctrine. To quote:[17] "contiguity is a necessary condition of association. But is it a sufficient condition? There is little in the experimental work on memory to indicate that it is sufficient, and much to indicate that it is not usually depended on to accomplish results. The things to be connected must be together, in order to arouse the reaction connecting them; but, unless they arouse some such reaction, they do not become connected, except it be very weakly." Professor Woodworth has shown some convincing experimental evidence[18] in support of his view and doubtless much more could be discovered by search through studies already in print,[19] but space will not permit us to go into the matter here.

In attempting to learn by reading, the subject does not rely entirely upon mere repetition of the syllables—upon the alleged efficacy of contiguity—alone, but in most cases, tries to form the serial associations upon which he must rely to recall the series when the time comes. Why are these bonds not definitely formed? The reason is that the presence of the printed words (S, S^1, S^2, etc.) makes it so unessential, during reading, to connect B with B^1, or M with B^1, that the learner's purpose to strengthen these bonds is defeated. Since, according to prescription, the learner must,

[16] *Op. cit.*, p. 51.

[17] 'A Revision of Imageless Thought', *Psychological Review*, 1915, **22**, pp. 1–27, especially pp. 16–22.

[18] It may be well to give the following sample test, in the words of the author. "I read a list of twenty pairs of unrelated words to a group of sixteen subjects, instructing them beforehand to learn the pairs so as to be able to respond with the second of each pair when the first should be given as a stimulus. But, after reading the list three times, I told them that they should, if possible, give also the first word of the following pair on getting the second word of the preceding pair as a stimulus.—The results were most definite: the second members of the pairs were correctly recalled in seventy-four per cent. of all cases, but the first members were recalled in only seven per cent. of the cases." 'A Revision of Imageless Thought'. *Ibid.*, p. 18.

[19] For example, see Hollingworth, H. L. 'Characteristic Differences between Recall and Recognition', *American Journal Psychology*, 1913, 24, pp. 532–544. Also 'The Influence of Caffein on Efficiency', *Archives of Psychology*, 1912, No. 22, p. 17.

on completing the series *S A B M*, then read S^1, the connections S^1 A^1 B^1 M^1 being by previous practice better established, are thrown into action before the incipient bonds B–B^1, M–B^1, are awakened. The response follows directly upon the stimulus provoked by seeing the word.

How is it possible, then, as shown by our quantitative results given earlier, that some memorization does result from reading? In all probability *pure* reading is a fiction; recall, to some degree, being always present. Nearly all subjects were able, introspectively, to discern this fact. Figure 5 shows, roughly, the physiology of this situation. The dotted lines S–A, S^1–A^1, etc., indicate that these bonds between the sight of the word and its expression are more feebly exercised; are less depended upon than is the case in Figure 4, which illustrates the hypothetical pure reading. The manner in which the items (S^1, etc.) are required to play a minor role are various. Sometimes the subject pauses between the series, *S A B M* and S^1 A^1 B^1 M^1, etc., thus permitting the bonds B–B^1, M–B^1, etc., to be thrown into action before S^1 is observed. That is to say, the subject anticipates the next word in the series, more or less, before he reads it. Sometimes the syllables are read in a hazy, inattentive way, in which case the subject relies partly upon the exercise of the serial bonds as well as upon the objective stimulus of the printed word. In these and other ways, *actual* reading departs from *pure* reading and in consequence leads more effectively to memorization. In short, the actual reading which the subject practices is a sort of hybrid between the hypothetical pure reading and recitation.

A more accurate picture of the anatomical substrata of memorizing would undoubtedly be much more complex than our simple diagrams. As we have seen, consciousness of the meaning and form of the material is a prominent factor in learning. Consequently, the diagram should contain at least a symbolic representation of the centers upon which, presumably, such consciousness depends. Thus, in Figure 7, *P*, a 'psychic' center may be added, in which elaborations of the sensory data take place.[20] Probably in learning a passage, as well as during the recall for some time, *P* is called into activity, discharging into *B*. As practice continues, in all likelihood, pathway *S A B M* becomes relatively more and more permeable, until finally conduction through *A P B* ceases almost entirely—the process becomes practically unattended by consciousness of meaning. To illustrate this condition for reading (illus-

[20] For an account of such distribution of functions, see Ladd and Woodworth, *Physiological Psychology*, chapters IX and X. The 'association' or 'psychic' areas are given special treatment on pp. 251–263.

trated by Figure 7) we may repeat the statement of one of our subjects: "The typewritten letters became, after four or five minutes, so many stupid hieroglyphics."

In recitation also, the 'psychic' center P is involved. Figure 8 is merely a suggestion of the possible connections of this center with others. P may have connections with B^1, as well as with P^1, which in turn, is connected with B^1, through which the discharge into the organ of expression takes place. If now we consider that each of these possible connections indicated by a straight line in the figure is a representation of hundreds, perhaps thousands of different neurones that may be employed, the complexity of the

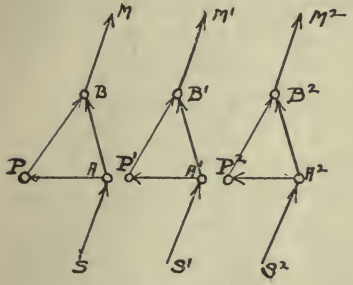


Fig. 7—Reading with awareness of meaning.

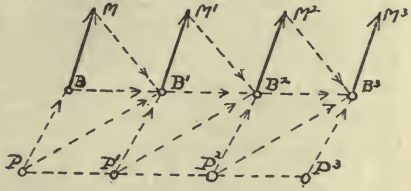


Fig. 8—Recitation with awareness of meaning.

neural substrate involved in learning is suggested. But recitation of the series of syllables may become short-circuited to a nearly mechanical activity, such that once initiated, the series of responses occurs automatically while attention is occupied with other matters. This may be typified by considering that the connections through P and P^1, etc., and perhaps even the connections B–B^1, etc., drop out, so that the connection of M with B^1, which leads directly to M^1, is so close that once the series of responses is started, each follows its predecessor with mechanical precision.

Recitation, in brief, differs from reading physiologically by the fact that it selects and exercises the bonds upon which the established habit depends, while reading calls into action some bonds that are not strictly needed for recall, omits some that are requisite, and does not so well exercise the remaining few, needed for recall. Recitation is for memorizing what practice is for other habits.[21] The physiological basis is the same.

[21] Such a physiological explanation, for example, has been worked out in detail by J. H. Bair for typewriting. See 'The Practice Curve', *Psychological Review Monographs*, 1902, No. 19, pp. 1–70.

Some of the differences between reading and recitation, which appeared from the introspective analysis of the two functions, may appear with more clarity when considered from the physiological side. For example, many subjects reported that the associative aids adopted during recitation were more constantly employed than those adopted during reading. Recitation results in the continued exercise of particular bonds, as we have seen, and of course each repetition strengthens those bonds, with the result that the nervous impulse once initiated flows along the most frequently traversed pathway. In reading, none of the serial bonds receives adequate exercise, with the result that none has a great advantage over any other, and now one, now another pathway may be traversed.

Annoyingness and fatigue in the case of prolonged reading may be considered as largely due to a check placed in the way of the exercise of the bonds desired. "When any conduction unit is in readiness to conduct, for it to do so is satisfying. When any conduction unit is not ready to conduct, for it to do so is annoying. When any conduction unit is in readiness to conduct, for it not to do so is annoying."[22] After the preliminary exercise of the conduction units *S A B M*, further exercise of that bond becomes annoying; the serial bonds are then ready to conduct. For them to do so, under the conditions specified in reading, is practically impossible, because the stimuli *S*, S^1, S^2, etc., by virtue of their firmer establishment, cause the conduction to take the habitual course, *S A B M*, etc.

Space will not permit further illustrations of this sort. By way of summary of this section, it is only necessary to repeat that reading and recitation are relatively distinct yet essential functions of the learning process. Each has its proper place, and as we have seen, introducing recitation too early or withholding it too long retards learning. The important matter is to determine the optimum point at which to introduce it, a matter which will receive consideration in the following section.

THE OPTIMUM TIME AT WHICH TO INTRODUCE RECITATION

The quantitative results presented in Chapter IV indicated that the optimum time at which to introduce recitation varied somewhat according to the age and training of the different groups of school children, and the data obtained from adults pointed to differences among individuals of approximately the same age and training. It is obvious that the determination of the optimum time at which to introduce recitation is a most important matter for purposes of economizing time and energy in learning. That the quantitative

[22] Thorndike, E. L., *Educational Psychology*, vol. II, pp. 1–2.

determination of the best combinations of reading and recitation made in the present study apply only to the particular conditions here employed, has already been pointed out. The optimum time for the beginning of recitation will doubtless vary not only according to the age, training, and capacity of the learner but also according to the kind of material, the length of the lesson, and the purpose in view, *i. e.*, whether the lesson is to be learned *verbatim*, whether the substance without the exact form is to be reproduced, or whether a less definite mastery is all that is desired. Consequently, a quantitatively precise rule cannot be made.

The present study, however, has produced some results that are suggestive. In general, all the evidence, quantitative, introspective, and interpretative seems to imply that recitation should be introduced early. Only a very small percentage of the total time required to learn should be devoted to reading. However, it seems to be a natural tendency of many adult subjects to make too early an attempt at recitation. Some of the reasons for the disadvantageous effect of introducing recitation may be pointed out. *First*, The bonds between the words and syllables and their correct pronunciation are not sufficiently well formed to permit successful recitation. *Second*, The advantageous effect of a preliminary determination of a line of attack is foregone in whole or part. *Third*, The amount of data that can be recalled at so early a moment is insufficient. The learner is likely to waste time in fruitless endeavor to recall syllables that are simply not as yet forthcoming. *Fourth*, Too much time is wasted looking on and off the text, 'finding the place' and the like. *Fifth*, Too frequent failures in attempted recalls break attention and may develop an unpleasant attitude on part of the subject. *Sixth*, Too many erroneous recalls may be made. When the learner has such slight acquaintance with the material as a whole, errors once made are likely to be repeated. Later these undesirable bonds must be broken down before the correct bonds can be formed.

Just as introducing the recitation too early has a deleterious effect, so does introducing it too late retard learning. The abundant quantitative evidence for this has been presented in Chapter IV.

The optimum combination of the two functions can be best expressed in this way. Reading should be continued until the learner is fairly familiar with the material as a whole and with the items of which it is composed. The learner should have decided meanwhile upon his general method of attack. Enough of the material should be clearly in mind so that the learner's first attempts at recall will meet with some success. Just how much is enough will depend largely upon the learner. As a guiding principle one

may consider that the first few recitations should not result in too great a distortion of the material, nor should it cause a waste of time in fruitless endeavor to recall. The capacity of the learner to quickly judge the status of his knowledge is of prime importance; he should be able to know at once whether continued effort to recall this particular syllable will end in success or not, and in the latter case time should not be wasted before reference to the text is made. The early stages of learning will thus employ both reading and recitation, the relative amount of the former decreasing as the learning progresses. Economical learning would consist, in part, in employing recitation, after it is once introduced, to the full, coupled with the capacity to speedily resort to reading where it is essential.

THE EFFECTIVENESS OF RECITATION IN LEARNING NONSENSE MATERIAL AS COMPARED TO LEARNING SENSE MATERIAL

The quantitative results of Chapter IV seemed to indicate two things: *First*, that the optimum time for introducing recitation was considerably earlier for nonsense than for sense material; and *Second*, that recitation seemed to be a more fruitful method of study in the case of nonsense material than in the case of sense material.

The first result is apparent rather than real. While it is true that recitation introduced very early produced richer returns for nonsense than for sense material, this should be considered in connection with the fact that the amount of material forming the lesson in the former case is but a small fraction of that used in the latter. Yet the amount of material should be considered only in connection with the difficulty of the material. While the nonsense material was much less in amount, it was very much more difficult to learn. A further consideration of this point is unnecessary since the factors which influence the introduction of recitation, just considered, are the same in either case.

The point with regard to the value of recitation as dependent upon the kind of material is important and demands further consideration.

The results have shown clearly that equal amounts of recitation produce richer returns in the case of senseless non-connected material than when connected senseful material is used. The reasons why this should be the case have been given in the previous sections of this chapter, and it is only necessary here to summarize the factors upon which this difference depends.

In the first place, it was found that recitation was of great service in assisting the subject to organize the material into some sort of compact and connected whole, such an organization being essential

to a thorough mastery of it. The particular means of accomplishing this organization were: the formation of bonds between the items and accents, modulations of the voice, pauses, and elements of a rhythm; the formation of bonds between items and their meaning, immediate or distant; the noticing of peculiarities in the text and the formation of bonds between items and their position for the purpose of breaking up the material into groups; the noticing of bonds between items and characteristics of the groups and so on. In short, recitation rendered great service in creating usable associations within the material where there was none, or in more adequately noticing and exercising those that were already present. In nonsense material these bonds between items are absent, and this process of organization and creation of associations is difficult and essential; learning of such material consists in accomplishing just this organization. In the connected sense material such as that used in the present experiment, most of these associations are already present; the material is already organized, the items are connected by serial connections of meaning, rhythms, and the like, by means of which the various elements are firmly knit together. The function of recitation for the formation of these bonds is not required. What is needed is that the ready-formed associations be noticed and exercised, although, in most cases, bonds in addition to those found in the material will be required.

A second reason for the better results obtained by reading in the case of sense material is closely related to the first and lies in the fact that reading is less 'pure' in studying sense material. As was remarked earlier, after a certain number of perusals the reading of either kind of material is probably not pure and becomes less and less so as the subject becomes more familiar with it. The more easily the material can be grasped, the less pure the reading becomes, as a rule. Nonsense material is always rather hard to articulate and hard to work with generally, and as a consequence, there is less of a tendency to depart from reading when it is prescribed. But in the case of connected sense material, the reader is usually already familiar with the words and phrases as such; only the combinations are new and doubtless not all of them. The greater fluency and greater familiarity of the material results in combining recitation with reading; only certain key words need be noticed, the gaps being filled in by recall. The learner can glance along the lines, scarcely seeing more than an occasional word which suggests the context.

The physiological explanation that was applied to reading and recitation in general can be equally well utilized to illustrate these points. In recitation the connections between the items (repre-

sented in Figures 7 and 8 by P–P^1, P–B^1, B–B^1, etc.) are, in considerable degree, already given in the material. In fact, the serial associations between the words of familiar phrases are already fixed in one's nervous system through earlier practice. Recitation, as a factor making possible the formation of many connections, is consequently not needed. In other cases where the connections are less definitely formed, only a small amount of practice is required to stamp them in. The result is that in so far as the connections are ready-formed, reading amounts in all essentials to recitation. The eye neglects many of the words as such, fixating only occasional points. Reading thus becomes far from pure and approaches recitation, in all likelihood, more and more closely as the learning advances.

VI

CONCLUSIONS AND PEDAGOGICAL IMPLICATIONS

A detailed summary of results will not be attempted at this point. Only a few of the results which are of practical importance for the work of the school-room will be repeated. The reader who wishes a more detailed account of the findings may refer to the summaries that are to be found at the close of the previous chapters.

The compilation of quantitative and introspective evidence has shown that reading and recitation are relatively distinct functions in the process of learning. Each has its proper office to perform, and to restrict the learning entirely to one or the other results in loss of time and energy. Reading, as the introductory function, should be employed until the learner is fairly well acquainted with the material as a whole; until a method for further attack has been tentatively adopted; and until the first attempt at recall will meet with some success without too great a distortion of the material. The optimum point for introducing it, thus, occurs early in the process, but to introduce it too early, as well as to introduce it too late, will have a detrimental effect. In determining the exact moment at which recitation can best be introduced, one must take into account the length of the lesson, the difficulty of the material, the kind of learning that is desired, the age, training, and general capacity of the learner.

The function of recitation, as we have seen, is similar to that of practice in any form of sensori-motor learning. Memorization consists in selecting certain essential bonds, eliminating the unfit, and exercising the former until the connections are so well formed that once initiated, the series of responses will occur in proper sequence. The laws of use and disuse apply here as in other forms of learning; the physiological basis is the same.

Since recitation is equivalent to practice in other forms of learning, we should expect as a matter of course that any restriction upon its employment during the process of memorization should result in retarding improvement. Our experiments upon this point have shown that this is the case. This was true for all subjects, except children so young as to be unable to meet the requirements of the test, and for all materials employed, although, as might reasonably be expected, minor differences are to be found. In general, a method in which recitation is introduced at the optimum

time, in comparison with a method in which the learner is entirely restricted to reading, enables the learner to reproduce immediately after a short period of study approximately twice as much material. The advantage of recitation as one should expect, is much more pronounced in delayed recall. After an interval of three or four hours, recitation makes possible the recall of four times as much material as does reading. This is to be expected, since recitation is understood as a process of adequate practice, while reading, whose function is introductory, restricts or inhibits the exercise of the bonds upon whose strength recall depends. In reading, while many of the bonds may be well enough established for immediate use, the neural connections rapidly disappear with disuse.

As the nature of reading and recitation now appears, the question is not so much—How is it that reading produces such poor results?—but rather—How is it that reading permits of any memorization at all? The evidence that has been gathered makes it doubtful whether *pure* reading would result in memorization. But there is little doubt that *pure* reading is a fiction; more or less recitation is always present in any prolonged effort to learn.

The fact that reading is seldom if ever pure can be most clearly illustrated in the case of learning sense material, and this fact helps us at the same time to understand why reading as a method of learning is more fruitful when applied to such material than when employed with non-connected senseless material. Nearly all of the subjects admitted that their learning, especially of sense material, was not limited to pure reading. The eye moved along the line actually seeing only occasional words. Other words, in fact whole phrases, were filled in by recall. The text served only to suggest groups of words or ideas which were for the most part filled in by the learner. In so far as this subjective reproduction of the material was carried on, to just that extent the learner was reciting rather than reading, and without doubt this sort of recall was at all times considerable, becoming more and more so as the learning progressed. Consequently, it appears that the memorization of the material, technically speaking, must, after all, be attributed to recitation.

The findings of Chapter IV were to the effect that reading was much more productive when the material was senseful and connected than when senseless and non-connected. The previous paragraph explains in part why this should be so. Reading of senseful connected material is far from pure, while with senseless material, on account of its less fluency and lack of senseful serial associations, the learner finds it less unnatural to actually see and read each item. No associations are present in the material which enable the learner

to fill in the gaps when only occasional syllables are read. The bonds between items must be built up by the learner himself, and it is in this process that recitation is of the greatest value. These two factors together, namely, that the bonds between items in nonsense material must be worked in by the learner and that reading is much more pure with this material, explain the relatively greater advantage which recitation brings about with nonsense as compared to senseful material.

In addition to the fact that recitation as compared with reading enables the learner to form the requisite bonds more quickly and more permanently, the results of Chapter V have indicated other advantages of recitation as a form of learning. It was found that recitation leads to greater certainty of one's knowledge. It enables the learner not only to know but to be aware of how well he knows. Fewer blunders and erroneous recalls are made. The material is better organized; it is in more usable form. The meaning of the material is better obtained, and the relations among parts become more clear. In addition to this, as Katzaroff found (see page 5), material learned by means of recitation can be more promptly recalled; the recitation time is less.

From every point of view the superiority of recitation over reading, beyond the few perusals required to furnish the initial grasp of the material, is very clear. It holds for all materials and for practically all subjects. Consequently, the applications of the results to pedagogy are direct and manifestly important.

For the improvement of methods of study among school children, it is first of all necessary that the teacher should be aware of the value of recall in learning and that she should endeavor to impart this information in a practicable way to the pupils. That the pupils cannot be depended upon to discover economical methods of studying by themselves has often been discovered by inquiry. Miss M. J. Baldwin,[1] for example, found for grammar and high school pupils "that eighty-two per cent. studied words rather than thoughts, that they study in a mechanical sort of way which enables them to say that they have studied the lesson and spent the required time. They read the words over and over and doubtless get more confused the more they read."

It is perhaps not sufficient, however, that the pupils should be merely aware of the fact that attempted recitation is an essential process in learning. The teacher must devise means by which the pupils may be induced to study by trying to recall the material rather than by merely continuing slavishly to read and reread the words. The determination of these means, of course, does not lie

[1] 'How Children Study', *Archives of Psychology*, 1909, No. 12, p. 70.

within the scope of this study. It has been the purpose here merely to show that the recitation method *can* be employed, and employed very effectively, by pupils from the third grade up.

A few things which may induce the pupil to rely more upon recall will occur to anyone. Any method which requires the summarization of the facts of the lesson brings recall into play, since in such a process the pupil must think over the whole material, cull out the essentials, and state in his own words the main points. The teacher should encourage the pupil to react to the lesson in this way and reward him for successful attempts. Condensations of the ideas in written form, or even better, if possible, summarizing the content of the lesson mentally, is almost certain to bring rich returns. It brings into play the beneficial factors involved in recitation, develops power to distinguish the essentials from the unessentials, and may develop confidence and satisfaction in the pupil, since it enables him to be more certain of his mastery of the material. The pupil who has reasonable assurance that he has the lesson in hand can approach the recitation before the teacher in a more effective frame of mind.

The fact that recall is of such great importance in learning has a significant bearing on the nature of the recitation period in the school-room. As Colvin has pointed out:[2] "The fact that the recitation, as such, is largely ignored in higher grades of instruction is doubtless a serious pedagogical defect, which can be remedied only by accustoming the student to practise on his own initiative recall in his learning." The recitation should be regarded not merely as an opportunity afforded the teacher to find out what the pupils know, how hard they have studied, and what grade they should be given. Instead of an inquisition it should become a period of instruction. It should offer the pupil an opportunity to recite material he has previously more or less completely mastered. If the silent pupils could be induced to recall the material as well as the pupil who is orally reciting to the teacher, the period could become a valuable opportunity for review. Its most admirable function would consist in affording the pupils an opportunity to discover where their knowledge is hazy, inexact, and uncertain.

In addition, the teacher should make of the recitation a means of discovering the methods of studying employed by the pupils and of suggesting improvements in that respect. The unprepared student should not simply be met by the remarks: "How many times did you read your lesson?" and "Go read it again!" but more detailed inquiry into the cause of failure, followed by more valuable suggestions with regard to methods of study, should be the pro-

[2] *The Learning Process*, New York, 1913, p. 165.

cedure. In a word: "It should be remembered that instruction in the technique of learning is perhaps as important as instruction in the content of the subjects of the school curriculum."[3]

More advanced students may profit by the knowledge of the indispensible value of recitation. The college student is confronted by a situation in which the 'absorbing' of knowledge seems paramount, and where reaction is too little required. Listening to lectures and reading the texts require most of his time; recitations are few and far between. That they 'read lots but learn little' is a stock criticism, and it is indeed not seldom true that the college student is quite as ignorant of economical methods of study as the grammar school pupil. Recently the writer heard the case of a college student who came to a professor of psychology for an examination of what he believed to be a very poor memory. The student asserted that he could read a lesson over a dozen times and still not know it. A brief examination showed his memory not to be below par, but all the evidence indicated entirely inadequate methods of study. The student relied upon impression with little or no effort at expression; recall of the main points of his lesson was seldom tried. Yet for the college student who is so seldom called to account for his acquirements, recitation is more than usually essential. Frequent reviews, thinking the matter over by one's self, writing briefs of the main points, conversation with other students, and the like, are valuable because they throw into relief the portions that are hazy, inexact, and confused as well as because they fix more clearly in mind the material that is rehearsed.

Various opinions have been expressed with regard to methods of taking notes during lectures.[4] Doubtless the method must be varied somewhat to suit the material that is presented, but the findings in the present study suggest a method which, although seldom employed, should bring good results. Instead of making of one's self a mechanism for transferring spoken words to paper with but little heed to the meaning, the student devotes his attention to a thorough understanding the material presented, selecting the important points, organizing them into a systematic whole as the lecture progresses, and for the most part, delaying to a later hour the writing of the notes. Later in the day or evening, the lecture is rehearsed and an outline written down for future reference. While some disadvantages, or more likely, inconveniences, of such a method may appear, certain advantages of an important nature are obvious. First of all, the student may develop better habits

[3] Colvin, *op. cit.*, p. 178.

[4] This subject will be found discussed at length in two recent books: G. V. N. Dearborn, *How to Learn Easily*, Boston, 1916, Chapter II, and Harry D. Kitson, *How to Use Your Mind*, Philadelphia, 1916, Chapter II.

of attention during the lecture. He forces himself to pick out the essentials, to grasp the relations of ideas and to unify and organize the material presented. The will to remember, which Meumann so strongly emphasizes, comes into play. The student must actively grasp the meaning of the lecture in order to be able to reproduce it later. Secondly, the writing of a brief of the lecture at a later hour combines the advantage of a recitation, which the copious note-taker too seldom practises, with the well known benefits to be derived from the distribution of learning periods.[5] A few students who have tried this method speak enthusiastically of its effectiveness.

Finally, a word with regard to a more technical application of the results of this study. Individuals, when permitted to study by their 'natural method,' were found to employ various methods, not only for different materials, but for lessons of the same material and of the same length, at different times.[6] The quantitative results consequently vary considerably, according to whether the subject does or does not happen to employ an optimum combination of reading and recitation. In experimental work on memory and learning in which successive tests under constant conditions are required, it would seem to be an important precaution to specify the time at which the learner should change from reading to attempted recall, with instructions to employ thereafter the recitation method until learning is complete.

[5] See Jost, A., 'Die Assoziationfestigkeit in ihrer Abhängigkeit von der Verteilung der Wiederholungen', *Zeitschrift für Psychologie*, 1897, **14**, pp. 436–472, or Ebbinghaus, H., *Memory*, translated by H. Ruger and C. Bussenius, New York, 1913.

[6] But little of the actual data bearing on this point has been presented in this paper. For the most part, such data were obtained from the practice tests conducted preliminary to those here presented.

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