

THE RELATION OF LENGTH OF MATERIAL TO TIME
TAKEN FOR LEARNING
AND
THE OPTIMUM DISTRIBUTION OF TIME.

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PART III.

One thing, probably the most important, that may be said in favor of the "once-per-day" method so far as economy is concerned, is the fact that material memorized by this method is retained for a much longer period than that memorized by the "continuous" method. This is probably its chief, if not its only advantage.

As no other subject was available who would undertake all of the various tests described in Part II, I have no complete curves for comparison. I have, however, the records¹ of six subjects on various parts of the test, e. g., one subject memorized a 500 word passage by the "continuous" method and then memorized it by the "once-per-day" method. Another subject memorized 48 nonsense syllables by the "continuous" method, 100 digits by the "continuous" method, a passage of 500 words by the "continuous" method and 30 stanzas by the "once-per-day" method. Space does not admit an entire reproduction of the records of these six subjects.¹ As one would expect, however, in an experiment of this kind, the various subjects differed greatly.

On another set of students² (fourteen Normal College girls) a somewhat different test was tried, the results of which, since they take but little room and are valuable for comparison with some of the preceding tables, are given below:

¹Some of these have already been given in Tables G, H, K, and N of Part I.

²These fourteen students were selected from the Junior and Senior classes of the Albany Normal College and were selected as being the fourteen foremost out of over sixty students, i. e., they stood highest in their general average in class.

TABLE O.

1	2	3	4	5	6	7	8	9	10
Subject	MATERIAL USED.								
	Nonsense Syllables			Digits			Prose		
	10	20	40	20	100	150	100	300	500
B. B.	5 min.	10 min.	28 min.	3 min. 15 sec.	57 min.	1 hr. 54 min.	8 min.	25 min.	42 min.
Ed. W.	5 min.	12 min.	31 min.	3 min.	46 min.	1 hr. 19 min.†	10 min.	24 min.	59 min.
El. W.	6 min.	13 min.	36 min.	2 min. 30 sec.		1 hr. 55 min.	12 min.	19 min.	1 hr. 7 min.
E. F.	7 min.	12 min.	37 min.	6 min.	54 min.		14 min.	47 min.	1 hr. 38 min.
E. B.	11 min.	20 min.	45 min.	8 min.	1 hr. 11 min.		13 min.	40 min.	1 hr. 43 min.
H. B.	13 min.	24 min.	58 min.	4 min.	1 hr. 37 min.		16 min.	26 min.	57 min.
A. K.	12 min.	23 min.	38 min.	7 min. 30 sec.	58 min.	2 hr. 16 min.	19 min.	29 min.	1 hr. 28 min.
A. H.	15 min.	29 min.	1 hr. 10 min.	6 min.	1 hr. 17 min.		15 min.	32 min.	1 hr. 15 min.
E. E.	12 min.	18 min.	51 min.	9 min.	1 hr. 3 min.		21 min.	37 min.	
F. W1.	16 min.	27 min.	1 hr. 17 min.	5 min.	1 hr. 22 min.		17 min.	36 min.	45 min.
R. W.	17 min.	31 min.	1 hr. 39 min.	7 min.	*		18 min.	51 min.	2 hr. 13 min.
A. Q.	13 min.	34 min.	2 hrs. 4 min.	10 min.	*		17 min.	48 min.	1 hr. 21 min.
E. A.	17 min.	37 min.	57 min.	11 min.	*		35 min.	1 hr. 18 min.	*
F. Wo.	16 min.	30 min.	*	4 min. 45 sec.	2 hr. 16 min.		31 min.	41 min.	*
Aver.	12 min.	23 min.	58 min.	6 min. 34 sec.	1 hr. 14 min.	1 hr. 51 min.	18 min.	38 min.	1 hr. 17 min.

*Given up after 2 hours.

†This subject's time for 200 digits was 1 hr. and 49 minutes.

Of the various individual differences in the group of six referred to on the preceding page, I found the greatest to occur with digits and nonsense syllables when memorized by the "once-per-day" method. I mean by this that the results obtained for memorizing such material by the "once-per-day" method differed more widely from the "continuous" method (in my own case) than did prose or poetry. To elucidate this fact, I give in Table P, the results of a certain experiment. Briefly stated, this experiment was as follows:

Sixteen subjects were selected from a list of over 100 as having averaged the best in a certain miscellaneous set of memory experiments. Ten of the sixteen subjects* occurred in the group of fourteen referred to on the preceding page. These sixteen names were then mixed up and eight selected at random for work on digits. The remaining eight were allotted prose. Of the eight digit-subjects, four were given a set of fifty digits, the other four were given a set of 200 digits. Of the eight prose-subjects, four were given a passage of prose 250 words long and the remaining four were given a passage of prose 1000 words long. The subjects were then read the directions and rules of the experiment. Briefly stated these were that the subject would be called on to read the material allotted her once a day, and once only (Saturday and Sunday included) until she felt confident she could write the passage without error. The method of scoring these reproductions and the methods of deducting for attempted reproductions that were not perfect enough to consummate the experiment, was somewhat elaborate. Suffice it to say that the scores given were made on a percentage basis of *perfection = 100*. It was directed that the subject read the passage at her usual rate of reading, thoughtfully, i. e., understandingly and either aloud or to herself as she preferred.

Table P gives the results of this experiment. They are somewhat different from what I had been led to expect and in one sense of the word, considering that the subjects were all "selected," are somewhat disappointing. It will be noticed that of the eight subjects assigned prose, all

*All the subjects were girls. They averaged in age from 19 to 23.

but one finished.⁴ The average number of days for the subjects using the 200-prose passage was 29 days. The average time taken for those reading the 1000-word passage was 48 days.⁵ Were the subject E. S. to be excluded the number would, of course, be lower. All of the subjects using the set of 50-digits finished within the 60 day limit; their average time is 41 days. With the 200-digit group of subjects the results were rather unsatisfactory. They were certainly (with reference to the experiments on myself) most unexpected. As will be seen from the table, only one of the four subjects, was able to reproduce satisfactorily⁷ the set of 200-digits within the time limit. The remaining three were requested to write

TABLE P.

1	2	3	4	5
Subject	Material	Days	Average No. Days (Using Column 5 in the calculation)	Score at Expiration of 60 days ⁶
E. F.....	50 Digits	40	41	
A. K.....	50 Digits	37		
E. A.....	50 Digits	48		
F. Wo.....	50 Digits	39		
Ed. W.....	200 Digits	51	68	92
B. B.....	200 Digits			
El. W.....	200 Digits			
A. H.....	200 Digits			
E. B.....	200 Prose	27	29	67
F. Wi.....	200 Prose	36		
A. Q.....	200 Prose	24		
F. S.....	200 Prose	28		
H. B.....	1000 Prose	40	48	
E. E.....	1000 Prose	49		
R. W.....	1000 Prose	28		
E. S.....	1000 Prose			

⁴Force of circumstances necessitated a discontinuance of the experiment after 60 days.

⁵Including the subject E. S. by using her "score" in the calculation.

⁶At the end of 60 days, those who had not completed the experiment were requested to write down as much of the prose passage, or set of digits, as possible. These reproductions were then "scored" on a percentage basis of "Perfection = 100." From these scores the probable number of days was then calculated in order that this might be used in calculating the "Average Number of Days" in Column 4

⁷Space does not permit here giving the method of scoring the reproductions. Suffice it to say that with the set of 50 digits a perfect score was 100 and with the 200-digit set, 400. An error of 4 points was allowed for the 50-digit set and 16 points for the 200-digit set. As previously explained, it is undesirable for many reasons to insist on a perfect reproduction. In fact in general it is best in memory experiments, where a comparison between the individuals is to be made, to continue the experiment only until the first subject has "finished," and then grade the others accordingly.

down as much as they were able of the material so that a score of some sort could be placed on their attempted reproductions. As shown on the table, their scores are fairly high. The most interesting fact, however, is that at the end of 40 days—the scoring of an “attempted reproduction” of these three subjects gave figures nearly as high.

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As has already been stated, (Part I), these two “methods”⁹ of memorizing contribute but a small fragment to the much larger problem of the *Optimum Distribution of Time*⁹—a problem which is but a minor contribution to the still more general problem of *Economy in Learning*. Such a problem, as we have already said, would have to consider not only the various sub-divisions of time, sub-divisions of material,¹⁰ nature of material, time of day, etc., but would have to include an investigation of such things as,—loud v. silent reading, fast v. slow reading, etc., etc.

As a matter of fact, no single method can be set down as being the most economical for everyone. The problem is not, *What is the most Economical Method?*, but *What is the most Economical Method for Mr. Brown and how can he find this method out?*

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Unfortunately space does not allow publication of all of my data. Were I to draw conclusions, however, from all my

⁹i. e. the “continuous” method and the “once-per-day” method.

¹⁰It has been proven by experiment that a certain effort expended at intervals over a period of several days will give better results than if this same effort is expended in one “sitting.” We do not, however, know the most effective distribution possible.—nor do we know whether this “most effective distribution,”—supposing it had been ascertained,—would apply to one material as well as to another. It has been proven that in general it is better if, say one hour is to be spent on a list of 40 nonsense syllables, to divide this hour up into sections, but the most favorable distribution has never been determined.

¹¹This problem of the most favorable sub-division of the material, or the most economical unit for committing to memory, is one that has received the attention of numerous investigators. The various phases of this subject have been taken up by Steffens, Pentschew, Schneider, Larguier des Bancels, Pyle and Snyder, and Lakenan. Steffens found that it was better not only not to divide a stanza of poetry into parts, but that for poems of moderate length, it was better not to divide the poem into stanzas. Schneider says that even for poems of 12 or 15 stanzas, the “best” (and as a rule he means by this the most economical) method, is to read and re-read the entire poem.

experiments, I should say that the following are the most significant:

1. For meaningful material such as prose and poetry the total time consumed by the "once-per-day" method is about the same as that needed by the "continuous" method. With both methods with passages of 1000 words or less the time varies directly as the length of the passage.

2. With nonsense syllables, digits, and all material memorized by motor associations the total time spent by the "once-per-day" method may be roughly said to vary as the length of the passage; by the "continuous" method, however, the time would seem to vary as the square of the length of the passage.

3. Visual presentation would seem to be better than auditory presentation, but a combination of the two, e. g., when the subject reads his own material aloud, would seem to be more economical and to give greater retentiveness than either. The superiority of visual over the auditory presentation would *not* seem to be alone due to the fact that two senses instead of one are called into play, but because we can read more easily and more exactly than we can hear;—a second reason is that visual presentation allows us to choose our own rhythm and rate of reading.

4. Things that make sense, i. e., meaningful material are learned in larger units than non-meaningful material. The subject is able to take the material as a whole for the reason that it makes sense, i. e., that it means something to him. In one sense of the word also, one might say that with meaningful material the subject has already (i. e., previous to the experiment) memorized a large part of it.

5. Subjects who have lately been taught mnemonic systems are apt to over-do them, i. e., they endeavor to apply them more often than is for their own good. Mnemonics only pay when easily formed and when easily remembered. Very often the task of forming associations and the difficulty of remembering them is greater than would have been the task of using, what we might term for want of a better word, "brute force."

6. With nonsense syllables, not only does one have to learn the constitution of the individual syllable, but the order of the

syllable as well. For words, their *order* is practically the only thing necessary, i. e., provided associations between the words have been formed.

7. With reference to the problem of the *most favorable distribution of single readings*, referred to several times in the preceding pages, I would say that "the most general statement that can be made, taking all materials and methods of presentation into consideration, is that the most economical method is to distribute the readings over a rather lengthy period,—the intervals between the readings being in arithmetical proportion. For example, with one individual in memorizing a poem of 20 stanzas the highest retentiveness was obtained by distributing the readings as follows: 2 hours, 8 hours, 1 day, 2 days, 4 days, 8 days, 16 days, 32 days, etc. The practical bearing of the results obtained on education in general"¹¹ is that when associations have once been formed they should be recalled before an interval so long has elapsed that the original associations have lost their "color" and cannot be recalled in the same "shape," time, and order. In general it was found "that the most economical method for keeping material once memorized from disappearing, was to review the material whenever it started to 'fade.' Here also the intervals were found to be, roughly speaking, in arithmetical proportion. For similar reasons the student is advised to review his 'lecture-notes' shortly after taking them, and if possible, to review them again the evening of the same day. Then the lapse of a week or two does not make nearly so much difference. When once he has forgotten so much that the various associations originally made have vanished, a considerable portion of the material is irretrievably lost."¹²

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The time taken to memorize nonsense-syllables as found by the various experimenters who have worked with them, is far from being always the same, even when the subjects are of the same age and intellectual standing. An examination of

¹¹*The Optimal Distribution of Time, and the Relation of Length of Material to Time Taken for Learning*: D. O. LYON. The Journal of Philosophy, Psychology and Scientific Methods, Vol. IX, No. 14.

¹²Op. cit. page 386.

the various sets of nonsense syllables used by these experimenters has proven to me that this difference in time is largely due to the great differences in the difficulty of the nonsense syllables used.¹³ Experiments of my own have confirmed this.

Were one to attempt to repeat the prose experiment, the results of which are given in Table O, he would arrive at approximately the same results if he used bright students, say the best quarter of a class of 60 or 70, even though he selected his prose passage at random from any novel.¹⁴

It is probable that with digits also, his results would be much the same. When, however, he came to nonsense syllables, his results would be liable to differ widely unless the sets of syllables used were equal in difficulty to those used by me. I give below the set of 40 syllables used in the experiment in question and would advise their use should anyone attempt to repeat the experiment for purposes of comparison.

KUV	ZID	KIF	NUZ	POZ
YAB	VEL	HEB	BOF	NIV
SEF	NAZ	YIF	JEP	DUT
RUP	JID	KEV	VOB	KEL
KED	LUP	NAD	FEG	VUM
TIB	MIV	TEF	YAB	JOP
WEF	VOB	KIV	VUZ	RAV
BOL	RUZ	JED	DIB	NID

Short sets of nonsense syllables are easily made,—repetitions of syllables being easily avoided. There are, for the English language, only about 90 fairly good nonsense syllables, and of these nearly 80 begin with J or N, end with B or D, or have O or U as their vowel. In making a series of say 40 nonsense syllables, from the 90 possible ones, it will be

¹³As an example of what I mean, I here give two examples of a series of nonsense syllables as given by Watt in a footnote in his book entitled "*The Economy and Training of Memory*."

"Bax, goul, fos, hiv, ped, vaub, jum, cor."

It is obvious that with such a set of nonsense syllables associations are very easily formed, e. g. with one individual these 8 syllables were memorized in 1¼ minutes by using the following words in place of the syllables which they so nearly resemble:

Box, ghoul, "fossa," live, pedestal, vault, jam, "body;"—all these being easy of recall in their proper order by visualizing a picture of a certain burial.

¹⁴My own prose passage with the group of 14 Normal College Students was taken from Dewey's *School and Society*.

found, *if the rules given in the foot-note below¹⁵ are followed*, that after the list has grown to 25 or 30, more than half of the syllables drawn have to be thrown back. Lists of 60 or more, are made only with considerable difficulty, and it is frequently found necessary to throw the syllables back¹⁶ and start over again. Sets of 90 syllables or over must contain either a certain number of undesirable¹⁷ syllables or a number of repetitions. For example, the set of 104 used by me with the "once-per-day" method contains three "DUT"s, two "BOF"s, two "POF"s, and two "ZIM"s;—not that these repetitions could not have been avoided, but their avoidance would have necessitated either the use of certain undesirable syllables, or a recasting of a large part of the entire set. This set of 104 syllables is given below :

MIV	VUD	LCD	JED	NOL	NAV
ZAD	FEV	FEG	KOV	PAB	FUD
PIB	ZIB	DUT	SEB	LIR	PEM
KED	LOD	KIB	TID	JEP	BOK
LUP	JAZ	NAZ	YUP	KOV	
TAV	POF	BOD	RUZ	TID	
NID	DUT	JEP	KEV	RUP	
HEB	BOV	WIB	YIM	YAB	
VUS	ZIR	NUZ	NUV	ROZ	
ZIM	VEL	ROV	JAD	HEB	
KUV	PID	YID	POZ	NIV	
JID	JUR	TEF	LEB	SEF	
BOF	NAD	BOZ	TID	BOL	
YAB	VOB	PEV	FEK	ZIM	
WEF	YIF	JUF	RUL	VED	
DIB	TEB	VIB	BOF	NAZ	
JAL	JOD	NAJ	ZID	DUT	
HUF	ZUB	FEK	YAB	POF	
NIZ	NIV	HUZ	SEF	VUM	
TOB	KOB	BOP	HUV	JOP	

¹⁵Rules for forming sets of nonsense syllables from the 90 nonsense syllables previously selected :—

1. Syllables must be drawn by chance.
2. Initial consonants must not be the same unless separated by two or more syllables.
3. End consonants must not be the same unless separated by two or more syllables.
4. Vowels must not be the same unless separated by two or more syllables.
5. The initial consonant of one syllable must not be the same as the final consonant of the preceding syllable.
6. Excepting sets of 72, or over, syllables may not be repeated.

¹⁶My method was to mix up the syllables in a box and draw them out at random—arranging them one under the other. Whenever a syllable was found to violate any of the above rules it was thrown back.

¹⁷By "undesirable" syllables I mean syllables that (1) are difficult of pronunciation, e. g., YUF; or (2) that permit of quick and easy associations, e. g., LUK.

(THE END.)