THE RELATION OF LENGTH OF MATERIAL TO TIME TAKEN FOR LEARNING

and

THE OPTIMUM DISTRIBUTION OF TIME.

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PART II.

I have given the preceding brief summary of the results of the various investigations on The Relation of Length of Material to Number of Repetitions, not only as an historical review of those who have worked along these lines, but also because it allowed me to bring in at the same time for purposes of comparison, results obtained from certain experiments of my own. These experiments will now be considered in detail.

It was stated in Part 1 that in investigating the relation of length of material to time taken for learning we may, in the learning, use various *methods*. In the following experiments only two were used. I have designated them as (1) the "continuous" method, and (2) the "once-per-day" method. In the former, the subject is allowed to memorize the material *en-masse,*—i. e., in one sitting;—in the latter, the subject memorizes the material by reading it once a day—and once only, until memorized. The curves shown in the following plates, therefore, show not only the relation of length of material to time taken for learning, but they give a comparison of the total time taken to learn any passage by the one method as compared with the total time taken to learn a passage of the same length by the other method.

As will be seen from the plates, with their accompanying tables, the length of time taken to learn a passage of prose or a set of nonsense syllables, depends in large measure on the *method used* in performing the learning. In one sense of the word, therefore, it would be more fitting to call this experi-

ment *The Relation of Length of Material to Time Taken for Learning when said Learning is Performed in one Sitting;* and, *The Relation of Length of Material to Time Taken for Learning when said Learning is Performed by the "Once-per-day" Method.*

The materials first used were nonsense syllables and poetry. With these the experiment was continued for 14½ months. Digits and prose were then substituted and the entire performance repeated. The manner of conducting the experiment was as follows:— On May 1, 1908, I memorized 8 nonsense syllables taking my time by the watch. In the evening of the same day I memorized a four-line stanza of poetry of twenty-four words. An interval of two days was then allowed to elapse. On the following day (May 4th) a similar set of eight nonsense syllables was read once. Realizing that this reading was not sufficient for a perfect reproduction, the syllables were laid aside to be read the following morning. On the evening of May 4th, a stanza of poetry similar to the one previously memorized was read thru once. A perfect reproduction of the stanza was possible after this one reading, so this finished the two sets of eight nonsense syllables and the two sets of one-stanza poetry passages, both for the "continuous" method and the "once-per-day" method. From previous work with nonsense syllables it had been found that, when memorized by the "once-per-day" method they "clung" with great tenacity, and it was deemed advisable, therefore, to allow an interval of one week to elapse before starting on the next set. Therefore, it was not until the morning of May 15th that the twelve-syllable set was started. In the meantime, however, i. e., on May 5th, a passage of poetry consisting of *two* stanzas was memorized by the "continuous" method. An interval of one day (May 6th) was then allowed to elapse and on May 7th a similar passage of two stanzas was read once and once only. Three readings were necessary to get this two-stanza passage, i. e., it was read on the 7th, 8th and 9th. An interval of one day was then allowed to elapse, after which a *three-stanza* passage was started.[1]

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[1] This is all shown on plates I, II, III and IV; plates I and II being for nonsense syllables and plates III and IV for poetry.

In this manner the experiment was continued for over fourteen months. Nonsense syllables were always read in the morning,—poetry, in the evening. After finishing each passage of poetry, whether by the "continuous" method or the "once-per-day" method, an interval of one day was allowed to elapse. With the nonsense syllables, however, a longer interval was deemed necessary—two days being allowed to elapse after each finishing with the "continuous" method and seven days after the "once-per-day" method. The reasons for making the intervals longer for the nonsense syllables are, of course, obvious. It should be said here that no other experiments on memory were conducted while this experiment was in progress, and neither nonsense syllables nor poetry of any nature was read during the entire period. To make the conditions of the experiment as scientifically accurate as possible, the nonsense syllables and poetry were taken at as widely different times of the day as possible,—the nonsense syllables being read in the morning before breakfast, and the poetry in the evening after supper. It was also deemed best to abstain from all reading for a period of at least one half hour both before and after the reading of each passage.

On June 28th, 1909, I finished with the passage of poetry consisting of 100 stanzas. On July 10th I finished with the set of 300 nonsense syllables. Feeling that the experiment had continued long enough with these materials as subject matter, I decided to repeat the experiment using this time, however, digits and prose. This new series of experiments was started on August 1st, 1909, and continued for three years, i. e., up to May 2nd, 1912.[2]

The nonsense syllables were selected and made into sets after a certain definite manner.[3] A typical set is given in Part III. As may be seen from Plate 3, the poetry ranged in length from one to one hundred stanzas both for the "continuous" method and the "once-per-day" method. The poetry selected was what is known as common meter, i. e., iambic verses in which the first line contains four feet and the second line three feet. As shown on Plate 3, however, (where the

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[2] This was so only for the prose. The digits were discontinued on August 10, 1910.

[3] Described in foot-note No 15, Part III, of this article.

"exceptional" type is printed in red) every fourth set of poetry used had six instead of four lines in each stanza. A typical example of the first type of poetry is given below. It is a stanza from Thomas Moore's *The Ring.*[4]

> "The female fiend no sooner heard
> Than, with reluctant look.
> The very ring that Rupert lost,
> She from her finger took."

As a typical example of the second type of poetry, I give Thomas Hood's *The Dream Of Eugene Aram,*

> "He told how murderers walked the earth,
> Beneath the curse of Cain,—
> With crimson clouds before their eyes,
> And flames about their brain:
> For blood has left upon their souls
> Its everlasting stain!"

It will be seen that this poem is of the same type as that of *The Ballad of Reading Gaol.* My reason for using these two types of poetry was that I wanted to see if the addition of two extra lines made any material difference with either the "once-per-day" method or the "continuous" method and if so, if the difference was greater with one than with the other.[5] It will be seen from a glance at Plate 3 that by neither method does the addition of the two extra lines make any perceptible difference in the time taken for learning,—outside of the fact, of course, that the stanza takes longer to read.

For prose I decided to use selections from four different authors, alternating one with the other as shown on Plate 7. The authors chosen were Spencer, Hugo, Schopenhauer and Ingersoll. Due to the fact that I alternated one author with the other, I at first made four separate curves, one for each author. It was seen, however, that there was so little difference with the different authors that one curve was thought sufficient. The selections from Schopenhauer took a somewhat longer time, due undoubtedly to the fact that the

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[4] This poem consists of sixty-two stanzas. The first 50 stanzas were used as the "50-stanza" set. As may be noted, the poem is of the same type as "*The Ancient Mariner.*"

[5] Stanzas of the shorter type averaged 24 to 25 words: stanzas of the longer type averaged 35 to 40. In Plate 3 in computing the total number of words I used the figures 25 and 35 respectively.

sentences are short and that one sentence has very frequently
but little logical connection with what has preceded. Personal
interest in each author and his subject matter is here of such
importance that this factor must be taken into consideration.
This, however, was one reason for using the different authors.

Here, as in the experiment with nonsense syllables and
poetry, the digits were read in the morning before breakfast
and the prose in the evening. No passage was started until
the one then in hand was finished.[5] Not only were no other
memory experiments allowed, but ordinary reading was ab-
stained from for a period of *at least* one half an hour both be-
fore and after the reading of the passage. Since, with the
"once-per-day" method, only one reading was allowed each
day, the actual time taken per day was very short. Where,
however, the passage was memorized in one sitting, the time
in the case of the longer passages was frequently very long,
e. g., that for the 1500 word passage being nearly two hours.
Passages longer than this were not attempted, except by the
divided time method, which method was continued up to a
passage of 15,000 words.

Space permits neither a detailed statement and explanation
of the facts shown in the various plates and tables nor the
various psychological conclusions that might be deduced there-
from. To a certain extent, however, these are self evident
upon comparing the curves of the different materials with
each other,—and again comparing the same materials as
memorized by the two different methods. Take, e. g., Plate 8
with its tables. It will be seen that the passage of 500 words
was memorized in as few days as the 250 word passage—nay,
it was even one day less. But now, as the passage is twice as
long, the *total* time consumed was twice as great and, there-
fore, the time taken varies, approximately, directly as the
length of the passage. The same relation holds true for the
digits and nonsense syllables but not to the same extent, for
the number of days needed for 200 nonsense syllables is con-

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[5] It should be mentioned that in the attempted reproductions, one error was
allowed for every fifty nonsense syllables or digits. In the case of the poetry
one "help" (but never more than one) was allowed for every three stanzas.
e. g., for the ten-stanza passage three "helps" were allowed. In the case of the
prose one mistake (of one word) was allowed for every 100 words.

siderably greater than that needed for 20. By the "one-read-
ing-per-day" method, however, it is evident that a *long* pas-
sage (or set of nonsense syllables) is learned in nearly as few
days as a short passage. Referring again to Plate 8. We
have noted that the 500-word passage was memorized in as
few days as the 250-word passage and that, therefore, the total
time varied directly as the length of the passage. Looking at
Plate 7, however, (which shows the curve for the "continu-
ous" method) we observe, that, whereas the 100-word passage
was memorized in 9 minutes, the 500-word passage took 52
minutes,—in other words, multiplying the passage by five,
multiplies the time by six.

The red "curve" on Plates 3 and 7 show the amount of time
spent on the various passages by the "continuous" method.
The black curve shows the total time spent in reading similar
passages by the "once-per-day" method,—the reading having
been done at the rate of five minutes per 1000 words. A com-
parison of the two curves would show that so far as poetry and
prose are concerned, one method is as economical as the other,
i. e., economical as far as *time spent* is concerned for the
tenacity of impression is, of course, much greater by the "once-
per-day" method.

When we examine Plate 5, however, which shows two simi-
lar curves for digits we find that the "once-per-day" method
is considerably more economical. The same is seen in the
plate for nonsense syllables—material which, like digits, is
memorized in my own case by motor associations.

As before said, Plate 3 shows (in red) the total time taken
to learn by the "continuous" method the various passages of
poetry ranging in size from one stanza to 100 stanzas, i. e.,
from 25 words to 2500 words. On the plate the *ordinates*
represent the number of stanzas; the *abscissas,* the number
of minutes needed. The average number of words in each
stanza is about 25, except those printed in red, which average
40 words the stanza.

Plates 4 and 5 have already been touched on. It will be seen
that here, as in the case of nonsense syllables, the total time
taken by the "once-per-day" method is much less than is that
by the "continuous" method.

The plates show that the total time taken by the "once-per-day" method is,—for the poetry and prose, nearly always as long as by the "continuous" method. For digits and non-sense syllables, however, i. e., material in which there is but little logical connection, there is a considerable saving of time by the "once-per-day" method. It may be said by way of objection that this is due to a more or less constant reviewing, possibly unconscious, between the various readings. This is, of course, possible, but even if so does not materially alter the conclusions that may be drawn from the curves.

As we have just said, the time by the "once-per-day" method varies approximately as the length of the material. When, however, we turn to the "continuous" method, we find that this relation holds only for the shorter passages. As soon as the passage becomes too long for the mind to grasp it as a whole, the time mounts up rapidly, as shown, e. g., on Plate 7. "This is much more strikingly shown when we examine the curve obtained for the digits. Here we see that although it took only 5 minutes to learn 24 digits, it took 2 hours and 34 minutes to learn 200—more than 31 times as long instead of 8. In short it is obvious that the "once-per-day" method is—to say nothing of giving a far superior retention—far more economical than the "continuous" method. This is especially so for material memorized by motor associations such as non-sense syllables or digits.'"

[1] *The Relation of the Length of Material to Time Taken for Learning.* D. O. LYON. Journal of Philosophy, Psychology and Scientific Methods. Vol. IX, No. 14.