

any warning, gave the signal for the subject to turn the page upon which he was writing, and continued to pronounce digits at the same speed. The subject was told that the words would be given in the same manner, but not quite so rapidly. The following words were then pronounced: angel, pickle, dirt, busy, onion, women. The last word was pronounced in such a manner that another word was expected by the subject, but the signal, "turn," was given instead, and the subject was told to write as many of these words as he could remember, to place them in the order in which they had been given, and to indicate by a line the place for each omitted word. The time each individual required to reproduce the words was recorded by a stop-watch.

After testing over 100 individuals the writer applied the test to groups of college, normal-school, and public-school subjects. Aside from immediate reproduction, records were secured after various intervals, ranging from  $\frac{1}{2}$  hour to 3 months. In all such cases a practise test of rapid folding of papers was added. After the words were pronounced the papers were promptly collected and the experimenter left the room. The subjects thought the work was ended, but at various times the experimenter reappeared and asked for the reproduction. The time for all group reproduction was limited to  $1\frac{1}{2}$  minutes.

The best results were secured immediately after presenting the stimuli. Practically the same efficiency was shown for the reproduction after 6 hours as for that after  $\frac{1}{2}$  hour. But there was a decided fall after 7 days and a still greater fall after 3 months.

No appreciable difference was shown in efficiency between the lower grades and the college students for immediate reproduction; but after various intervals there was a gradual decrease in efficiency with age.

Of the 1,515 subjects, 757 females and 758 males, only 29 of the former and 18 of the latter reproduced the six words in exact order.

In all grades the females were markedly superior to the males, both for the number of words remembered and for order. They had a higher central tendency and were more variable than the males in the 5th, 6th, 7th, and 8th grades, while for the other groups the males were more variable.

108 other subjects were tested with 10 letters and digits. Here the girls answered more, but the boys were better for order.

*The Effect of Distribution of Practise Upon Learning:* ELMER A. CULLER.

The purpose of this experiment was twofold: to determine the effect of differently distributed practise series upon learning given

material; and to make observations upon the learning process in general.

The material to be learnt was the path from the beginning to the end of the Hampton Court maze. The paper (8 by 6 inches) on which the maze was printed, was affixed to a board. Over it was placed a large circular piece of cardboard, easily movable, having in the center a small opening ( $\frac{5}{8}$  to  $1\frac{1}{16}$  inch) through which extended a pencil to mark the course of the subject's movement. At no time could the subject see more of the maze than the part visible through the opening. At the beginning of the experiment the subject was thus instructed: Pencil is now at the entrance to the maze; keep on moving until you reach the end. Never cross a line; always keep to an open path. Mazes are all the same and will be placed in the same position.

At each trial the time was recorded and number of errors was counted and recorded. To each subject were given 12 trials. Subjects were divided into 6 groups as follows: 12 trials at one time, 6 on 2 successive days, 4 on 3 days, 3 on 4 days, 2 on 6 days and 1 on 12 days. There were 5 men in each group except the last, in which were 3. With regard to time of day, subjects were divided into two groups: one group each day for the required number of days, after lunch (1-2 P.M.): the second group each day after dinner (7-8 P.M.). In comparing men of the two groups no account was taken of this slight difference, as it was considered practically negligible. Good light was uniformly provided. The interval between successive trials of a subject at the same sitting was 30-40 seconds.

Subjects were all graduate students, age from 22 to 28.

Three classes of errors appeared: Wrong choice between alternative courses, retracing when on right course, and (accidentally) crossing a line. The first kind are major errors (value 1) and the other two kinds minor (value  $\frac{1}{2}$ ). These are arbitrary values for computing results. The major errors were counted as follows: There are 6 (or 7, depending upon the course taken) places where choice must be made between alternative paths of which only one is right. Each time the subject moved from one of these places in a wrong path, *i. e.*, away from the goal, it was counted one error. Errors of retracing when on the right path were usually small and due to defective attention or eyesight—subject either thought he had accidentally passed an opening and moved back to see, or on coming to a turn failed to notice the opening and thought he had run into a blind alley.

The results are as follows:

I. TABLE OF ABSOLUTE TIME AND ERROR VALUES ATTAINED IN EACH GROUP  
(The different groups are indicated thus: One—12, etc.; the word indicates

the number of trials each day, the figure the number of successive days. The two columns show the average of number of seconds consumed and number of errors made in the last three trials in each group; thus showing the relative standing of groups at end of practise period. The figures in parentheses show relative position.)

	Time, Per Cent.	Errors, Per Cent.
One—12 .....	50 (3)	4.8 (4)
Two—6 .....	61 (5)	5.2 (5)
Three—4 .....	59 (4)	3.2 (3)
Four—3 .....	39 (1)	.9 (1)
Six—2 .....	75 (6)	5.5 (6)
Twelve—1 .....	48 (2)	3.0 (2)

II. TABLE OF PERCENTAGE GAINS

(In each case the percentage represents the ratio between the average of first three trials and last three trials in the same group. This table is intended to show improvement of each group irrespective of absolute values attained.)

	Time, Per Cent.	Errors, Per Cent.
One—12 .....	210.0 (4)	147.9 (5)
Two—6 .....	253.0 (3)	161.5 (4)
Three—4 .....	195.0 (6)	302.0 (1)
Four—3 .....	341.0 (2)	218.5 (3)
Six—2 .....	206.6 (5)	125.3 (6)
Twelve—1 .....	368.7 (1)	236.6 (2)

(It must be said that the results of Six—2 were vitiated by the professed indifference of one subject, because of which both time and errors for the last few trials in that group are abnormally high.)

The results seem to point to the following conclusions: In general, outside the Six—2 group, the One—12 and Two—6 groups made the lowest absolute records and also least improvement; this apparently indicates that the learning period was too prolonged, with insufficient practise at any one time. On the other hand, the Twelve—1 and Four—3 groups show in general the highest absolute records and greatest improvement. Here the practise was more thorough each time and not so prolonged. The curve of greatest regularity is the Four—3 curve. The three groups, then, in which practise periods were longer and confined to a few days show better results than the three in which practise periods are shorter and prolonged over 4–12 days. The application to learning any material would seem to be that better results are secured by a few more prolonged or persistent periods of study repeated perhaps for several days than shorter periods prolonged over a greater number of days.

Some observations were made on individual methods of learning which can not be included here.