Short-term retention and presentation rate¹

M. S. Mayzner and K. M. Schoenberg
NEW YORK UNIVERSITY

Abstract

Four groups of 30 Ss each were presented with lists of numbers 18 digits in length on a memory drum, one digit exposed at a time, at four different presentation rates, 4 sec. per digit, 2 sec. per digit, 1 sec. per digit, and .50 sec. per digit. The 4 sec. rate was presented for 1 cycle, the 2 sec. rate for 2 cycles, the 1 sec. rate for 4 cycles, and the .50 sec. rate for 8 cycles, holding total display time constant (72 sec.) for all four conditions. Short-term retention decreased as presentation rate increased, even with total display time held constant.

Problem

The effects of presentation rate on the short-term retention of a string of digits presented visually has been examined by Mackworth (1962a, 1962b). In one study (Mackworth, 1962a) strings of eight or nine digits were presented at rates of 2, 1.5, 1, .50, and .25 sec. per digit and it was found that increasing the speed of presentation produced significant reductions in the amount retained. A second study (Mackworth, 1962b), in which some conditions involved strings of nine or ten digits presented at rates of 1, .50, and .25 sec. per digit, again found marked reductions in the amount retained at the faster presentation rates.

In studies of the type just described in which presentation rate of the stimulus items is varied, and inter-stimulus times are sufficiently small to be considered negligible in terms of any effects they might have on retention, the total display time for the series must also vary. For example, eight digits presented at the rate of 2 sec. per digit gives a total display time of 16 sec., while the same eight digits presented at the rate of .25 sec. per digit gives a total display time of only 2 sec. Since for sequential presentation total display time will always vary as a function of presentation rate for a given number of stimulus items (inter-stimulus times assumed negligible or constant), it was felt that it might be of some interest to hold total display time constant, but still vary presentation rate by presenting the same stimulus items for more than one cycle (cycle referring to one complete presentation of the stimulus series). For example, with a total display time of 16 sec., eight digits could be presented for one cycle at a rate of 2 sec. per digit, or for two cycles at a rate of 1 sec. per digit, or for eight cycles at a rate of .25 sec. per digit. The present study, therefore, was designed to examine the effects of different presentation rates with total display time held constant by varying the number of cycles employed in displaying the stimulus items.

Method

A Lafayette memory drum (Model 303B) was used to present the stimulus material, which consisted of eight lists of 18 one-digit numbers, with the constraint that the first and last nine digits of each list contain all of the digits from one to nine just once. The eight different lists were generated randomly and subsequent analysis showed that no particular list yielded superior or inferior recall scores in contrast to any other list.

A 4 x 8 mixed analysis of variance design (Edwards, 1960, p. 227) was employed with 30 different Ss assigned randomly to each of the four main conditions with eight trials or lists per S per condition. The main variable of presentation rate was examined at four values, 4, 2, 1, and .50 sec. per digit. The slowest rate, 4 sec. per digit, was employed for just one cycle and to maintain a constant total display time of 72 sec. for the remaining three rates of 2, 1, and .50 sec. per digit, two, four, and eight cycles, respectively, were employed for these faster rates. A red line was used to separate cycles, alerting S that the sequence of 18 digits that he had just observed one at a time in the window of the memory drum was about to repeat itself. Further, S was informed of the number of cycles to be employed for his particular condition. Each S was allowed 20 sec. to write down in the correct sequence the 18 digits he had just been presented, before continuing to the next trial, and the number of correct digits in the correct position served as the dependent measure of the study.

Results and Discussion

Table 1 presents the means and standard deviations for the total number of digits correctly recalled, summed across the eight trials, for the four different presentation rates and cycle combinations. The results of the 4 x 8 mixed analysis of variance yielded a $p < .05$ for the F-value of 3.45 associated with presentation rate and a $p < .01$ for the F-value of 5.59 associated with trials. The interaction of presentation rate with

Table 1. Means and SDs for the total number of digits correctly recalled, summed across the eight trials, for the four different presentation rates and cycle combinations

	Presentation Rate (sec./digit)			
	4 sec. - 1 cycle	2 sec. - 2 cycles	1 sec. - 4 cycles	.50 sec. - 8 cycles
Mean	76.7	71.8	71.8	62.9
SD	14.5	21.2	16.3	12.7

trials was not significant with a F-value of 1.18. The significant increase in recall scores from trial one through trial eight was approximately 1.5 digits, with, for example, the mean recall scores on trial one versus trial eight for the four presentation rates as follows: 4 sec. - 8.5 to 10 digits, 2 sec. - 7.3 to 9.2 digits, 1 sec. - 8.4 to 9.7 digits, and .50 sec. - 7.0 to 8.4 digits. This improvement in recall scores with practice also was found for digits in a previous study by Mayzner & Schoenberg (1965), but another study (Mayzner & Schoenberg, 1964) employing letters rather than digits found no improvement with practice and raises the question as to whether practice produces differential effects on the retention of letters versus numbers.

The main finding of the present study, showing a decrease in recall scores as presentation rate increases from 4 sec. per digit to .50 sec. per digit, is in agreement with results obtained by Mackworth (1962a, 1962b). Of particular interest, however, is the finding that this decrease in recall scores occurs even when total display time is held constant by increasing the number of display cycles. Even for the condition in which the presentation rate is .50 sec. per digit and S observes the 18 digits for eight display cycles, recall scores are the lowest of the four conditions examined. Thus, the results indicate that observing a list eight times produces far poorer recall than observing that same list just once, if certain changes occur in presentation rate. This finding would seem to suggest that neither repetition alone nor total display time alone are as critical as presentation rate in the short-term retention of digits. Such a conclusion is somewhat at variance with results obtained by Bugelski (1962) and Murdock (1960) who, in general, found total

display time to be more important than presentation rate, however, neither of these studies employed digits nor a comparable experimental design. Most recently, however, Johnson (1964) reports a study somewhat comparable to Bugelski's study in which total time, presentation rate, and frequency factors all show significant effects. Also, the results of the present study may present an interesting interpretative challenge for one-trial and incremental learning theories in that in the present study repetition combined with certain presentation rates produces decrements rather than increments or no effects on recall scores. Obviously further work is needed to separate unequivocally the effects of presentation rate, number of cycles or repetitions, and total display time on short-term retention processes.

References

- BUGELSKI, B. R. Presentation time, total time, and mediation in paired-associate learning. *J. exp. Psychol.*, 1962, 63, 409-412.
- EDWARDS, A. L. *Experimental design in psychological research.* (Rev. ed.) New York: Rinehart, 1960.
- JOHNSON, N. F. The functional relationship between amount learned and frequency vs. rate vs. total time of exposure of verbal materials. *J. verbal Learn. verbal Behav.*, 1964, 3, 502-504.
- MACKWORTH, J. F. Presentation rate and immediate memory. *Canad. J. Psychol.*, 1962a, 16, 42-47.
- MACKWORTH, J. F. The effect of display time upon the recall of digits. *Canad. J. Psychol.*, 1962b, 16, 48-55.
- MAYZNER, M. S., & SCHOENBERG, K. M. Single-letter and digram frequency effects in immediate serial recall. *J. verbal Learn. verbal Behav.*, 1964, 3, 397-400.
- MAYZNER, M. S., & SCHOENBERG, K. M. Short-term storage and retrieval of paired-associate material. *J. Psychol.*, 1965, 59, 113-123.
- MURDOCK, B. B. The immediate retention of unrelated words. *J. exp. Psychol.*, 1960, 60, 222-234.

Note

1. This research was supported in part by Contract Nonr 285(56) between the Engineering Psychology Branch of the Office of Naval Research and New York University.