In M.M. Gruneberg, P.E. Morris, & R.N. Sykes (Eds.), Practical Aspects of Memory (pp. 625-632). London: Academic Press. (1978).

OPTIMUM REHEARSAL PATTERNS AND NAME LEARNING

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ABSTRACT

Two kinds of practice are distinguished. In one, new information is presented repeatedly for study. In the other, often exemplified in name learning, a fact is presented just once, and subsequent rehearsal takes the form of "tests". Previous results and theory suggest that different schedules of rehearsal may be optimal in the two cases. We report experiments on name learning that compared various rehearsal patterns. Given a fixed number of rehearsals in a fixed period, a pattern of increasing intervals between successive rehearsals was best for test-type practice, while uniform spacing was slightly better if the information was repeated.

INTRODUCTION

Memorization usually occurs under circumstances in which an outside source provides the information anew on each practice trial, as when a student recites vocabulary words in preparation for a test. The proper scheduling of practice in this kind of situation has been much studied. Often, however, one wants to remember a fact that is presented just once, under circumstances in which it is difficult to record the information externally for later consultation. Name learning exemplifies the problem nicely. Writing down the names of people one meets at conferences is awkward; snapping pictures to pair with the names is downright gauche. The rehearsal mode that is available in such situations can be characterized as a series of self-administered tests. The optimal scheduling of tests as learning trials has also been studied experimentally (e.g., Landauer and Eldridge, 1967; Izawa,

1966, 1967; Whitten and Bjork, 1977), but less extensively.

For good experimental reasons, investigations of scheduling effects in either mode have seldom involved more than variation in the spacing between two trials on the same item. There has been virtually no work on non-uniformly spaced sequences of 3 or more trials. (But see Foos and Smith, 1974.) However, real practice commonly utilizes many trials, and in test-type practice where new information may be totally lost without rehearsal, multiple trials and non-uniform patterns take on special interest.

One account of test-spacing effects (Landauer, 1969, 1975; Whitten and Bjork, 1977) assumes that tests with successful outcomes are like repetitions. The longer the interval from initial presentation to test, the lower the probability of success but the greater its benefit for long term retention. Expanded, this idea suggests that the optimal schedule for test-type rehearsal would be a pattern of increasing intervals between successive tests. A first test-trial at a short interval would be likely to succeed and strengthen an item sufficiently to survive a slightly longer interval that would yield a more effective second practice trial, etc. In contrast, when the information is repeated, very long intervals are not as much better than moderate intervals and very short intervals are worse (see e.g., Landauer, 1969) so uniform spacing should be better for repetition-type practice.

EXPERIMENT I: LAST NAMES FOR FIRST NAMES

Method

Subjects were the 468 students attending an introductory psychology lecture at the State University of New York at Stony Brook. (We thank them and Professor Z. Coulter.) Each student was given a prearranged deck of cards bearing - for initial presentation trials - first and last names of fictitious people or - for test trials - first names only. Subjects turned through the cards at a 9 sec. rate in time to a signal, studying and writing last-name answers as appropriate. Next there was a 30 min. retention interval filled with a distracting lecture, followed by a final retention test.

The subjects were told to imagine they were at a cocktail party, meeting people they wanted to remember. The 50 study phase cards "introduced" a total of 16 fictitious people, of which 4 were recency and primacy buffers. The remaining 12 names were presented and tested on cards whose order in the deck produced various rehearsal patterns. Two

were presented once, i.e., both first and last name appeared on a card and neither name appeared again until final test. The rest of the names occurred four times each during the study phase. Initial presentation gave both names, the next three presentations only the first name and a space for attempted recall of the last name. There were, thus, three intervals, filled with other presentations and tests, separating the four study phase cards for each name. The number of intervening items in the three intervals were arranged in five classes of patterns, as follows. Uniform, short: (0,0,0 and 1,1,1. Uniform, moderate: 4,4,4 and 5,5,5. Uniform, long: $9 \leq (x,y,z) \leq 11$, mean = 9.3-10.3. Expanding: 0,3,10 and 1,4,10. Contracting: 10,3,0 and 10,4,1. Each subject's deck contained two examplars of each class. The mean interval of the uniform moderate patterns matches those of the expanding and contracting. The hypothesized superiority of the expanding patterns can thus be evaluated against both uniform patterns and patterns with the same distribution of intervals in the opposite order, where each contains the same practice events in the same total period. Uniform short mimics what naive people usually do (Landauer and Ross, 1976) and uniform long represents what one might prescribe on the basis of previous research on repetition-type spacing.

In addition to the information described above, for half of the critical names in each deck, study-phase test cards presented fictitious occupations for the named people. This manipulation had no discernable effect on rehearsal pattern differences. In producing card decks two entirely different sets of names were used. Rotation insured that particular names were used equally often in each pattern condition. Four different list orders were used; overall the list positions occupied by the first and last event in each pattern type were closely matched. Final tests were given in random order, and decks were distributed to subjects in random order.

Results

Fig. 1 shows proportions correct during the study phase of the experiment. The list position of each test relative to initial presentation of both names together is given on the abscissa. Variants of pattern classes that did not produce noticeable differences have been combined; (10,10,10 summarizes all variants of uniform-long spacing).

Fig. 2. Gives results on the final test. Here again variants of pattern classes yielding indistinguishable results

have been combined. The abscissa is average spacing, e.g., 4,4,4 and 5,5,5 combined are plotted at 4.5.

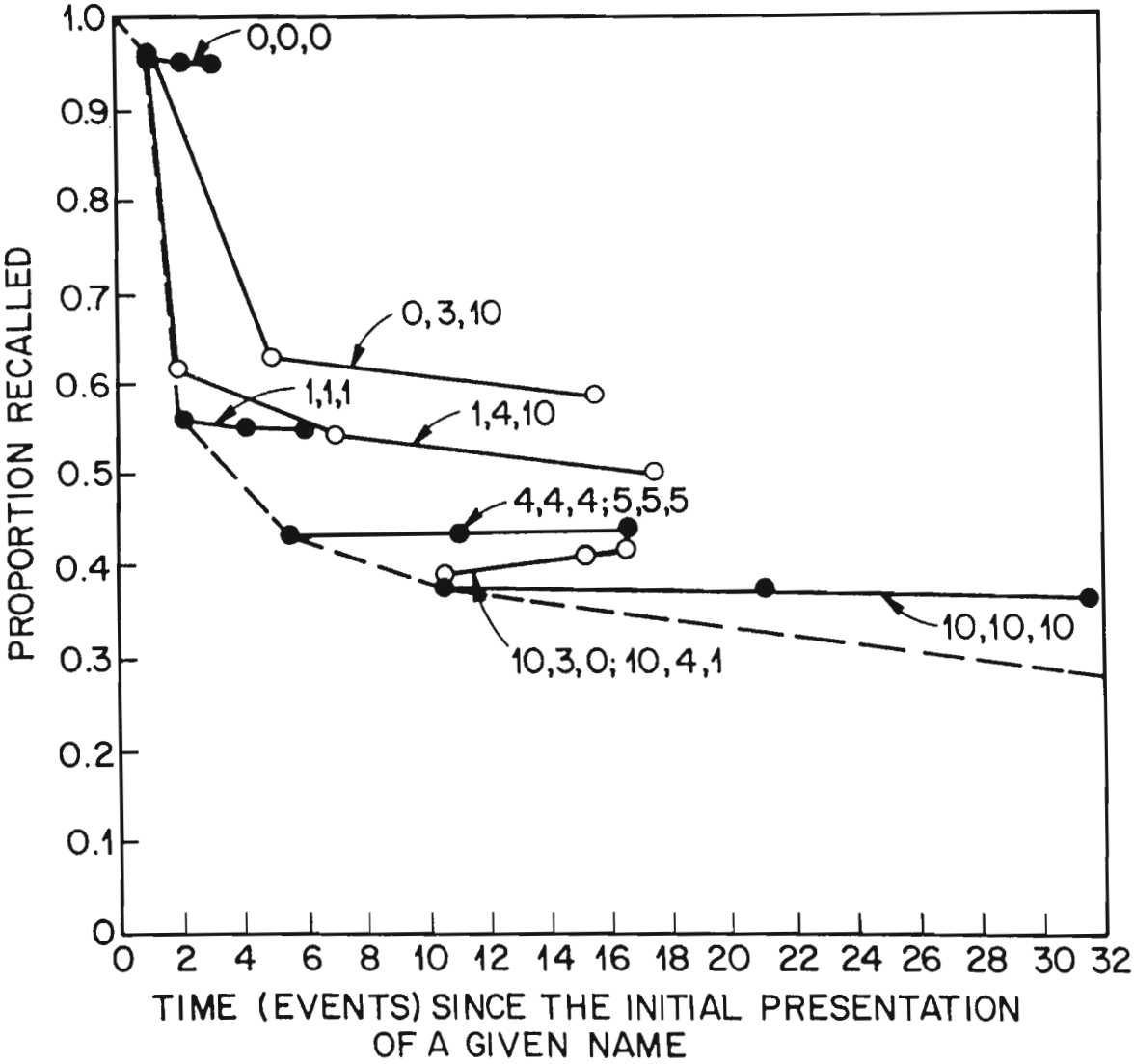

Fig. 1. *Exp. I. Performance on intralist tests.*

The expanding pattern produced almost twice as many correct final recalls as a presentation alone, the situation in which subjects determined their own rehearsal strategies. The expanding pattern was substantially better than the comparable uniform conditions, $z = 2.6$, $p < .01$, which were in turn somewhat but not significantly better than the contracting pattern. The forgetting curves in Fig. 1 are consistent with the idea, postulated above, that the expanding pattern is superior because it keeps the probability of a successful test relatively high. Note the short-term forgetting difference between the 0,3,10 and 1,4,10 patterns, which led to .49 and .45 correct on final tests respectively.

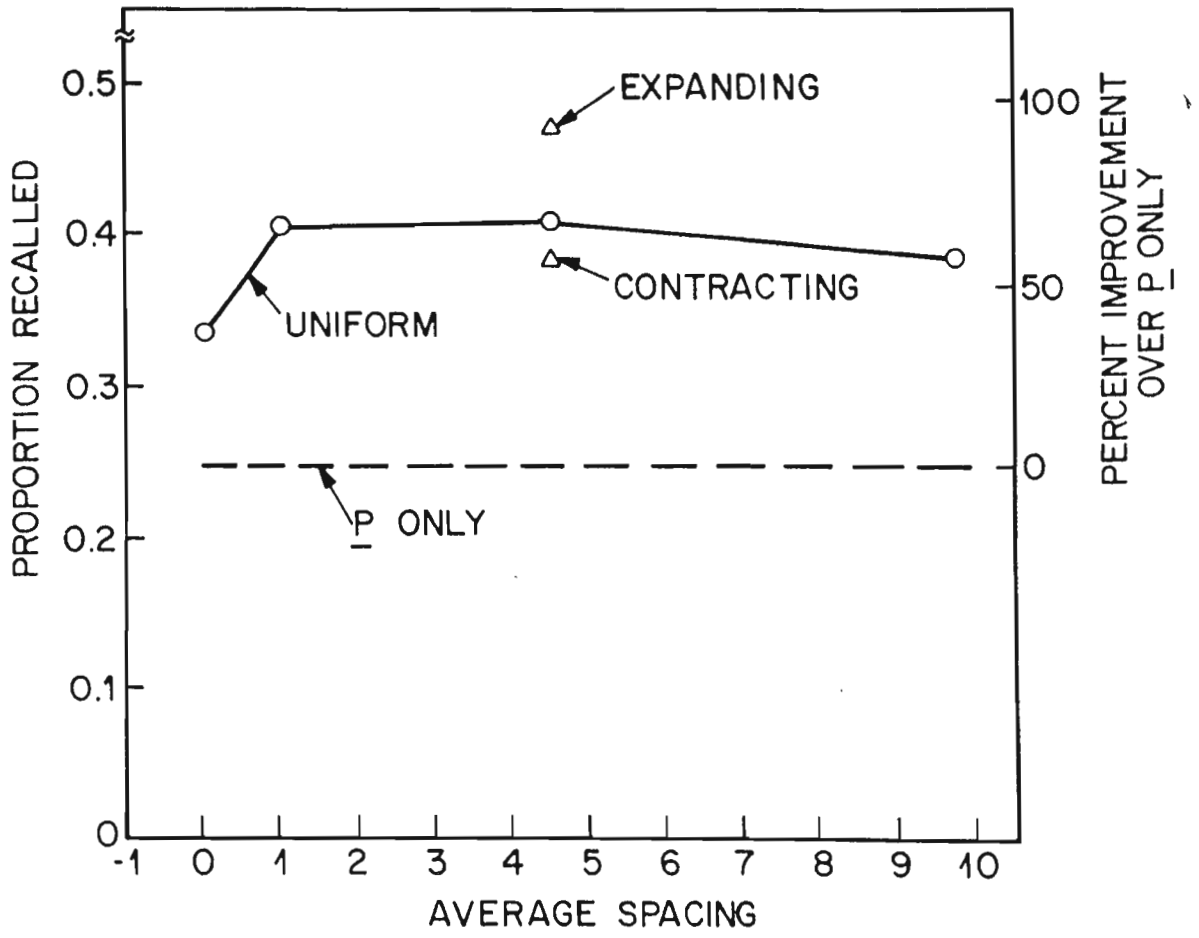

Fig. 2. *Exp. I. Performance on final tests. (P - names given only initial presentation).*

EXPERIMENT II: FIRST AND LAST NAMES FOR FACES

Method

Subjects were 218 students attending an Introductory Psychology lecture at the University of Illinois at Chicago Circle (we thank them and Professor E. Kent). The procedure (including control balancing) was similar to that of Exp. I with the following differences. The stimuli were standard, frontal photographs of heterogeneous faces. A 3x5 matrix of faces was projected in front of the class. The matrix disappeared and reappeared with the faces randomly permuted every 15 seconds. At each slide change, the subjects turned to a new card which bore a coordinate reference, e.g., A-5, to a particular face in the correspondingly labeled row and column of the display. The first time a face was referenced, both the first and last name were given on the card. During the study phase, succeeding cards referring to that face gave

either only the first name or only the last name, the other to be written by the subject. Thus for a given fictitious person one name was subject to repetition practice, the other to test-type practice. Two rehearsal patterns were used; one of 3,3,3,3 intervening events, judged the best uniform spacing on the basis of results shown in Fig. 2, and an expanding pattern of the same mean interval, 0,1,3,8 ,which, also on evidence from Exp. I, was expected to be optimal. There were two exemplars of each pattern, one with the first name repeated and the second tested, and the other vice-versa, plus three "people" given only initial presentation, at equated list positions, plus 11 buffer cards involving 8 "people". On test trials face references only were given and subjects attempted to supply both names. Three sets of names were used. Face-name, and face-condition pairings were permuted across subjects.

Results

Proportions correct on both intralist and final tests for test-type practice are shown in Fig. 3. Because there were no differences dependent on whether first or last name was the one tested or repeated, this distinction is ignored, yielding 436 observations per point.

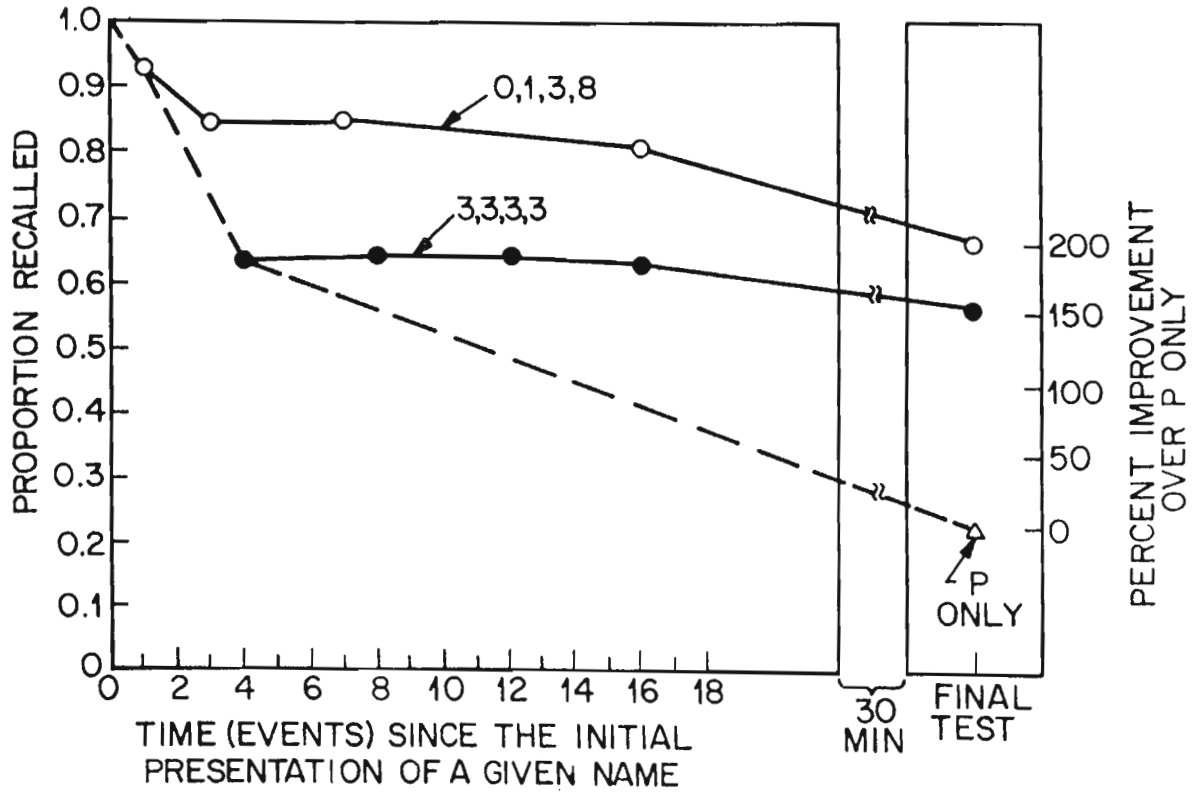

Fig. 3. *Results for test-type practice in Exp. II.*

As in Exp. I, the expanding pattern produced better final recall than the uniform pattern with the same average spacing; .66 and .56 correct respectively, $t = 3.16$, $d_f = 217$, $p < .01$. The absolute level of recall is impressively high for information presented just once as part of a long, highly similar list and tested over 30 minutes later. The proportions for which repeated information was recalled correctly were .58 and .62 for expanding and uniform patterns respectively. While this difference is not significant, the interaction between test-type and pattern is, $F = 18.72$, $d_f = 217$, $p < .001$. Thus, the expanding pattern is better than the uniform for test-type practice, but the uniform pattern is at least relatively better for repetitions.

It bears note that the best condition of all was the expanding test-type rehearsal, and it was significantly better than the corresponding expanding repetition pattern, $t = 3.56$, $d_f = 217$, $p < .01$.

Discussion

Expanding pattern test-type rehearsal offers an attractive mnemonic principle for retention of information that cannot be conveniently recorded. Indeed, popular mnemonic systems (see, e.g., Lorayne and Lucus, 1974) appear to induce just such a pattern of rehearsals, but attribute their claimed success to the demanding elaborative rituals in which the rehearsals are imbedded. The straight-forward rehearsal strategy suggested by the present results may be easier to apply in practical settings. To learn the name of a new acquaintance at a conference, one may be unwilling to shift cognitive power from technical discussion to rich associative imaginings, but may be willing to try the name as an implicit or explicit response to the face four or five times at increasing intervals.

Theoretically, the superiority of test-type practice over repetition in the expanding case can be explained if it is assumed that successful tests are more effective than repetitions. This could either be because tests induce greater encoding effort, or because they are more similar to the performance required at eventual recall. The expanding pattern may thus be seen as an effective shaping procedure for successively approximating the desired behavior of unaided recall at long delays.

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REFERENCES

Foos, P. W. and Smith, K. H. (1974). Effects of spacing and spacing patterns in free recall. *Journal of Experimental Psychology*, 103, 112-116.

Izawa, C. (1966). Reinforcement-test sequences in paired-associate learning. *Psychological Reports*, 18, 879-919.

Izawa, C. (1967). Function of tests in paired-associate learning. *Journal of Experimental Psychology*, 75, 194-209.

Landauer, T. K. (1969). Reinforcement as consolidation. *Psychological Review*, 76, 82-96.

Landauer, T. K. (1975). Memory without organization: Properties of a model with random storage and undirected retrieval. *Cognitive Psychology*, 7, 495-531.

Landauer, T. K. and Eldridge, L. (1967). Effects of tests without feedback and presentation-test interval in paired-associate learning. *Journal of Experimental Psychology*, 75, 290-298.

Landauer, T. K. and Ross, B. H. (1977). Can simple instruction to space practice improve ability to remember a fact? An experimental test using telephone numbers. *Bulletin of the Psychonomic Society*, 10, 215-218.

Lorayne, H. and Lucas, J. (1974). *Memory Book*, Stein and Day.

Whitten, W. B. and Bjork, R. A. (1977). Learning from tests: Effects of spacing. *Journal of Verbal Learning and Verbal Behavior*, 16, 465-478.