

## Picture Memory Improves with Longer On Time and Off Time

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Both recognition and recall of pictures improve as picture presentation time increases and as time between pictures increases. Processing of the pictures, rehearsal and/or encoding, continues after the picture has disappeared, just as for verbal material. Both the results and conclusions stand in contrast to those of Shaffer and Shiffrin.

In an experiment testing recognition memory for pictures, Shaffer and Shiffrin (1972) found improved performance as a result of increasing picture presentation time ("on time"), but no improvement from increasing the length of the blank interval following a picture ("off time"), where off time varied from 1 to 4 sec. Since verbal items can be rehearsed (reiterated) during off time, the exposure time of words is essentially irrelevant to memory (Atkinson & Shiffrin, 1968), although the total time (on time plus off time) is related to memory. The authors concluded from their findings not only that "there can be no analog of verbal rehearsal in the visual memory system that can be applied to moderately complex visual stimuli," but also that "no additional encoding or other transfer to long-term storage is going on in the visual short-term memory during the blank time, at least for the processing of complex visual stimuli after 1 sec" (p. 295).

In experiments testing both recall and recognition memory for pictures, Tversky (1973, 1974) found considerably improved performance as a result of the use of appropriate encoding strategies. Since encoding strategies, like rehearsal, benefit from additional time (on time or off time), it seems quite likely that increasing either on time or

The authors wish to thank Elinor Mamon for extensive assistance in preparing, executing, and analyzing the data of the experiment, and Ed Susskind for statistical advice. This experiment was supported by a grant from the Human Development Institute of the Hebrew University and a grant from the Batsheva de Rothschild Fund.

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off time should improve picture memory. If so, why did Shaffer and Shiffrin fail to find an effect of off time on picture recognition? There are several possible explanations. In their experiment, off times were randomized rather than blocked, which might have interfered with using different or any encoding strategies during the off time. Moreover, recognition performance was quite high in all conditions (eliminating the .2-sec exposure time where performance was close to chance), so that the recognition test might not have been sensitive enough to detect differences. Finally, whatever encoding or rehearsal processes that might occur during the off time might have their effect primarily on recall, rather than recognition, of pictures. The present experiment overcomes these difficulties and provides a stronger test of the effect of off time in picture memory: Both on time and off time are blocked; a more difficult recognition test is introduced, demanding discrimination of the original picture from another, similar picture of the same object; and, finally, a recall test is added prior to the recognition test.

### METHOD

#### *Materials*

The stimuli were 60 dictionary-type drawings of familiar objects, e.g., television, teakettle, fish, kangaroo, tent. Each distractor for the recognition test was a similar drawing of the same object. Examples of stimulus-foil pairs are presented in Figure 1. Pictures were presented as slides projected by Kodak Carousel projectors. Tachistoscopic shutters attached to the projectors and operated by a Massey-Dickinson timing device controlled on and off times of pictures. The room was dimly illuminated at all times to prevent formation of afterimages.

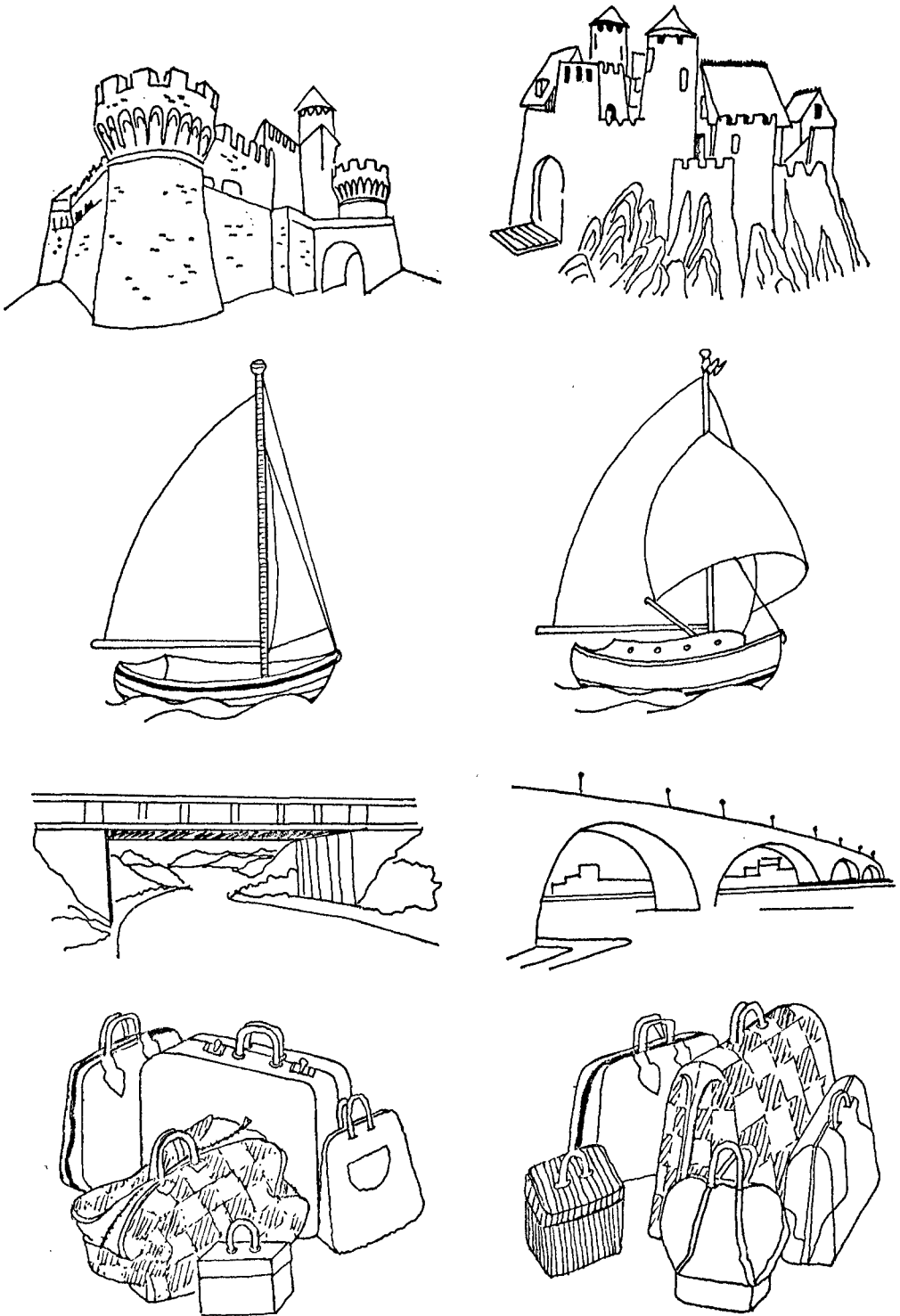


FIGURE 1. Examples of stimulus-foil picture pairs.

### Subjects

The subjects were 32 undergraduates at the Hebrew University who were fulfilling a course requirement. An additional subject, who had not understood the instructions, was discarded. The subjects were run in groups of up to 5.

### Design

There were four picture durations (on time) of .25, .50, 1.00, and 2.00 sec and two interstimulus intervals (off time) of 1.50 and 3.00 sec. Each subject served at all on times and at one off time. On times were blocked, 15 consecutive trials per block, and appeared in one of two orders: .50, 2.00, .25, 1.00 or 1.00, .25, 2.00, .50. These orders were chosen to minimize confounding with serial position and to distribute practice effects. Subjects were randomly assigned to one of the four groups obtained by factorially combining the two on-time orders with the two off times. One sequence of pictures was used in all conditions for presentation and for recognition test.

### Procedure

Subjects were instructed that following the presentation of the 60 slides, they would be given a test of free recall. The instructions advised subjects that their recall would be facilitated if they attempted to find categories or relationships among the items, and to use these groupings to organize the stimuli and guide their recall. Subjects were also informed of the specific block structure of on times and off times of the pictures. Following presentation of the 60 pictures, subjects were allowed 6 min for free recall. They were then asked to participate in a recognition test. Pairs of pictures, each stimulus and its distractor, were presented for 6 sec/pair and subjects were asked to

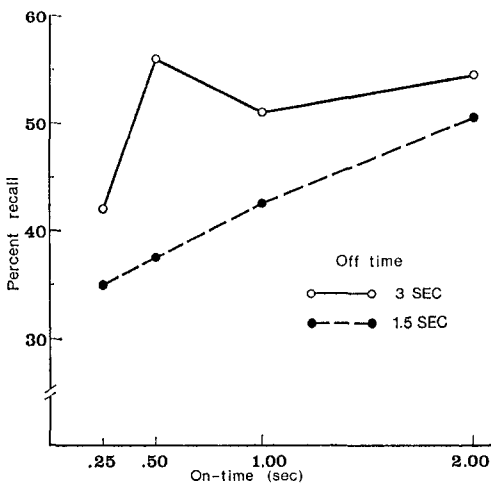


FIGURE 2. Mean percent recall as a function of picture duration (on time) and interstimulus interval (off time).

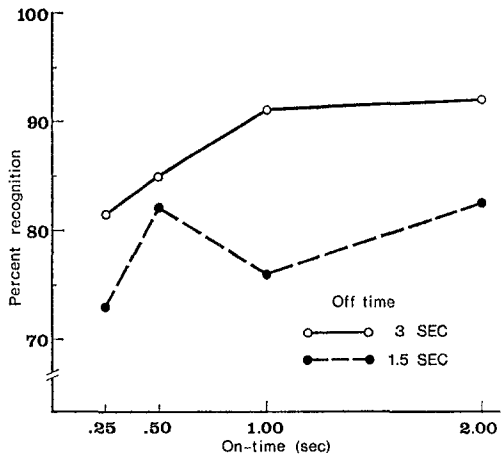


FIGURE 3. Mean percent recognition as a function of picture duration (on time) and interstimulus interval (off time).

mark whether the left or right stimulus had appeared originally. On half of the trials at random, the original stimulus appeared on the right in the recognition test. Previous research with half of these stimuli in a similar task had indicated that a prior test of free recall did not affect performance on a recognition task (Tversky, 1973).

### RESULTS

Percent correct recall and recognition as functions of on time and off time are presented in Figures 2 and 3, respectively. Separate analyses of variance were performed on each of the dependent variables, recall and recognition, with off time, on time, and on-time order (nested in subjects) as factors. The effect of off time was significant for both recall,  $F(1, 28) = 6.3, p < .025$ , and recognition,  $F(1, 28) = 23.4, p < .01$ . Off time accounted for 10% of the total variance in recall and for 19% of the total variance in recognition. The effect of on time was also significant on both recall,  $F(3, 84) = 4.9, p < .01$ , and recognition,  $F(3, 84) = 5.4, p < .01$ . On time accounted for 7% of the recall variance and 6% of the recognition variance, considerably smaller proportions of the total variance than those accounted for by off time. The average within-group standard deviation was .162 for recall and .098 for recognition.

The only additional significant effect was the interaction of on time with order of on times in recall,  $F(3, 84) = 3.1, p < .05$ , accounting for 8% of the variance and the ir-

regularity in Figure 2. The nature of the interaction was that recall of the first block of trials was slightly depressed or recall of the last block of trials enhanced. This phenomenon, essentially a serial position effect, could be interpreted as either a warm-up effect or a recency effect, or both. The irregularities at .5-sec on time for recognition, at 1.5-sec off time, and for recall at 3.0-sec off time seem to be attributable to enhanced performance in the condition where pictures presented at .5-sec on time occurred in the final part of the list.

*Total Time Hypothesis*

While the experiment was not designed to test the hypothesis that the total time, on time plus off time, is the essential factor in picture recall and recognition, the results replotted in Figure 3 do not contradict that hypothesis.

*Correlations Between Recognition and Recall*

Phi correlations were computed between recognition and recall scores of each subject at each on time and over all on times. These correlations were very low and were not related to increases in on time or off time, nor were there any consistent individual differences. The average correlation was +.075, with 27 subjects with positive correlations and 5 with negative. Although there are significantly more positive correlations than expected by chance,  $\chi^2 (1) = 15, p < .001$ , the average proportion of variance in recall and recognition scores accounted for by the correlation is negligible. (See Figure 4.)

DISCUSSION

Both recognition and recall of pictures are improved by increasing picture exposure duration as well as by increasing the blank time between pictures. Apparently, the physical presence of the picture is not necessary for continuing its rehearsal or encoding. This finding is not particularly surprising for recall of the names of the objects depicted. Subjects had been prepared for recall and advised to use an encoding strategy of organizing and interrelating similar objects. Such a strategy emphasizes verbal processes, which are known to benefit from

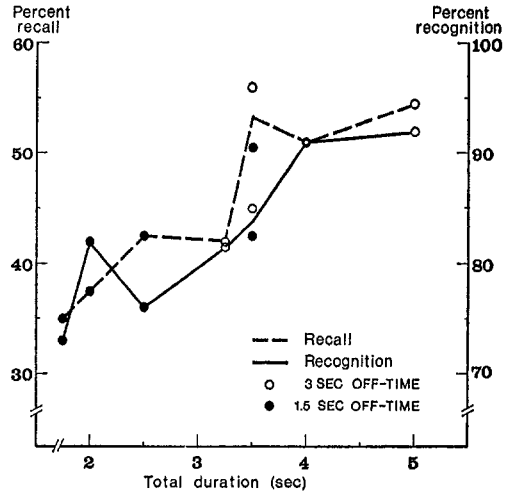


FIGURE 4. Mean percent recall and recognition as a function of total duration (on time plus off time).

additional time for encoding even in the absence of the stimuli. For instance, facilitation of recall of visual forms by increasing off time was found by Del Castillo and Gumenik (1972), who attributed their result to the availability of a verbal code at the longer off time.

The improvement in recognition performance with increased exposure time is consistent with the results of Shaffer and Shiffrin (1972) as well as with those of Potter and Levy (1969). The improvement in recognition performance due to increased off time, however, is quite surprising. Pictorial information was essential for passing the incidental recognition test, and the instructions had encouraged verbal organization. Moreover, the virtual absence of a correlation between correct recognition and recall indicated that subjects were retrieving different information to pass each test. Nevertheless, increased blank time between pictures facilitated their recognition, indicating that rehearsal and/or encoding of the pictorial content of stimuli continued into the interstimulus interval. The present findings are consistent with those of Posner and Konick (1966), who found evidence for visual rehearsal of simple stimuli; retention of a dot position on a line declined over time with an interpolated task filling the retention interval, but not with a blank retention interval. The

rehearsal or encoding processes that occur in the blank time in the present task and in Posner and Konick's task and that serve to improve retention are distinctly different from those described in Sperling (1960) and Averbach and Coriell (1961), where for very briefly presented stimuli, retention declines sharply as cuing or report are delayed over a blank interval.

Better picture recognition with longer blank time after the picture is not consistent, however, with the results obtained by Shaffer and Shiffrin (1972). While there are several differences between that study and the present one, the most likely cause of the conflicting results is the blocking of off times, which presumably allowed subjects to utilize the time between pictures more effectively for encoding to memory. The studies also differed in a number of other aspects, any of which could have contributed to the differences in findings: in stimuli (photographs vs. complex drawings), in memory task (yes-no vs. forced choice), in list length (120 vs. 60 items), and in instructions. Shaffer and Shiffrin did not specify their instructions, although presumably their subjects were set for recognition while the present subjects were set for recall.

In the present experiment it could be argued that subjects in the shorter off-time condition reduced their effective on time in order to start encoding for recall earlier. Subjects in the longer off-time condition would, the argument goes, utilize all the on time for observing the pictures because of the lengthened off time. Thus the off-time effect would be explained as a systematic reduction of effective on times in the 1.5-sec off-time condition rather than increased opportunity for stimulus encoding in the 3.0-sec off-time condition. This explanation seems unlikely for a number of reasons. First, the overall level of recognition at the .25-sec exposure with 1.5-sec off time is considerably higher (73% correct) than in the .25-sec exposure condition with no off time in Potter and Levy's (1969) experiment (around 35% correct) and in Shaffer and Shiffrin (1972), where the average confidence rating for the .2-sec exposure was barely above equivocation. This is in sharp

contrast to performance at an exposure time of 1.0 sec, where the subjects of Potter and Levy (over 80% correct) and Shaffer and Shiffrin (average confidence over 5 where 6 is certainty) with no blank time between slides are outperforming the present subjects (76% correct) with 1.5-sec off time. Moreover, since the present data were collected, another study that found an effect of off time on picture recognition (Weaver, 1974) has come to the authors' attention. In Weaver's experiment, subjects were presumably set for a recognition task and viewed photographs, as in Shaffer and Shiffrin's experiment. Off times, however, were blocked and varied between subjects, as in the present experiment. Thus, under amenable conditions the processing or encoding of a picture, like that of a word, continues into the unfilled time subsequent to the picture in such a way as to render the picture more accessible for recall and better discriminated in recognition.

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(Received June 18, 1974; revision received September 13, 1974)