Perception and memory for pictures: Single-trial learning of 2500 visual stimuli[1]

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Ss were shown 2,560 photographic stimuli for 10 sec each; their recognition memory was then tested, using a two-alternative forced-choice task. Performance exceeded 90%, indicating retention of over 2,000 items, even when up to 3 days elapsed between learning and testing. Variants of the experiment showed that the presentation time could be reduced to 1 sec per picture without seriously affecting performance; also, that the stimuli could be reversed in orientation in the test situation without impairing recognition performance appreciably. The orientation of the stimuli could also be learned, although not as well as the identity of the pictures. These results indicate the vast memory for pictures possessed by human beings and emphasize the need to determine mechanisms by which this is accomplished.

Shepard (1967) presented Ss with 600 pictures for a few seconds each and then asked them which member of various test pairs had been among the 600 (the other member of each pair was drawn from the same original population as the experimental stimuli, but was novel to S). Surprisingly high performance was obtained, since Ss correctly recognized the "old" stimulus in 98% of the test pairs. Other studies of picture memory have also suggested a large capacity for visual information and good retention of pictures over time (e.g., Nickerson, 1965, 1968).

The present study comprises four experiments. The first two examine memory for approximately 1,000 and 2,500 pictures, respectively; the third examines the effects of duration of viewing; and the fourth concerns the effects of reversing the stimuli between the learning and test sessions, and of the memory for orientation as well as identity of pictures. In each experiment, Shepard's general procedure is followed.

A total of 21 University of Rochester summer students was used in the four experiments; each participated in only one experiment. All Ss under a single experimental condition were tested together. They were paid on an hourly basis.

Except for the first experiment, the stimuli were projected from 35-mm slides, using a projector equipped with an automatic timer. The interval between slides was about ½ sec. The maximum luminance of the stimuli was 800 mL; a constant background luminance of about 2 mL was present as an adapting field. The stimuli were viewed from 12 ft, providing a maximum visual angle of about 14 deg.

In the first experiment, the stimuli were 1,100 magazine photographs, taken haphazardly from news, travel, and sports magazines without regard to color, size, content, or familiarity. The pictures were mounted on 8 x 11 in. cardboard and presented on a reading stand.

Two Ss were shown each stimulus for 5 sec each and two Ss for 10 sec each. This required about 2 and 4 h, respectively. Following a 30-min rest, each S was given 100 test trials, each consisting of a pair of pictures, one selected randomly from those shown and paired with another from the same original population that had not been seen by S. The positions of the old and new stimuli were randomized (left-right) for each trial; the test stimuli were taken in random order. The S's task was to indicate which one had been in the 1,100-item set. He was given as much time as he wished (averaging about 3 sec per pair).

The results showed that the two Ss given 5-sec presentations were correct on 99 and 95 test trials; the Ss given 10-sec per picture both scored 96%. Assuming that the proportion of stimuli that S remembers is $2P - 1$, where P is his probability of a correct response on this two-alternative forced-choice recognition task, the first two Ss remembered 1,080 and 990 of the 1,100 pictures, while the second two remembered 1,010. These estimates are clearly above chance, since according to the binomial distribution, the standard error of these estimates of total memory due to sampling error is less than 3%.

In the second experiment, a set of 2,560 stimuli was drawn randomly from a substantially larger population, consisting of 35-mm slides obtained from amateur and professional photographers. About 96% were colored, and approximately 7% contained appreciable symbolic information (letters, words, or numbers). The stimuli comprised a typical collection of snapshots, and were roughly classified into the following categories: human 37%, animal 5%, vegatation 13%, mineral 7%, city scenes 24%, mechanical objects 13%, and miscellaneous 1%.

Three Ss were shown 640 stimuli per day for 10 sec each, which took about 2 h per day on each of the 4 successive days, while two Ss were shown 1,280 slides per day for 2 days. During the learning trials, a 10-min rest pause was given after each hour. Both groups were then given 280 test trials (70 drawn from each 640 slides), commencing 60 min after the last learning trial and following the same plan as the test trials in the first experiment. As before, the order of test stimuli was randomized.

The Ss who viewed over 4 days scored 95%, 93%, and 85% correct on the 280 test trials. These correspond to recognitive memory of 2,300, 2,200, and 1,770 pictures, respectively. The number of errors occurring on test slides from the 4 days were: 14, 18, 26, and 22, respectively, corresponding to 3, 2, 1, and 0 days' retention. The Ss who viewed over only 2 days scored 89% and 90% correct (2,000 and 2,020 stimuli remembered). The number of errors on the first through the fourth quarter of the stimuli, corresponding approximately to 1.5, 1, .5, and 0 days' retention, were 10, 12, 21, and 20.

In the third experiment, four Ss were used. The stimuli were 120 slides, selected randomly from those used in the second experiment, except that none of them contained symbolic information. Each was flashed for 1 sec. Following a 30-min rest, Ss were tested for memory. Each of 120 pictures was paired with an unfamiliar one, but for each of 60 of the previously seen stimuli, its orientation was reversed. The percentage of correct choices made by the four Ss was 92%, 94%, 88%, and 91%.

In the fourth experiment, four Ss were shown the same stimuli as in the third experiment, but for 2 sec each, and were tested for memory after 30 min. The Ss were required both to identify the stimulus that they had seen before within each pair, and further to specify if it was in the same orientation as it was when they previously saw it. None of the stimuli provided any reversal cues (e.g., reversed lettering) and all were clearly asymmetrical. Another four Ss were tested in the same way, except that 24 h elapsed between the learning and test trials.

The results are summarized in Fig. 1. For both groups, retention of the identity of the stimuli was high, and, as with the third experiment, reversal of the test stimuli did not make them harder to recognize. However, the judgments of test stimulus orientation were somewhat poorer, particularly after 24 h.

The overall pattern of results of the four experiments leaves little doubt that Shepard's (1967) results are generally valid, and that picture memory is even larger

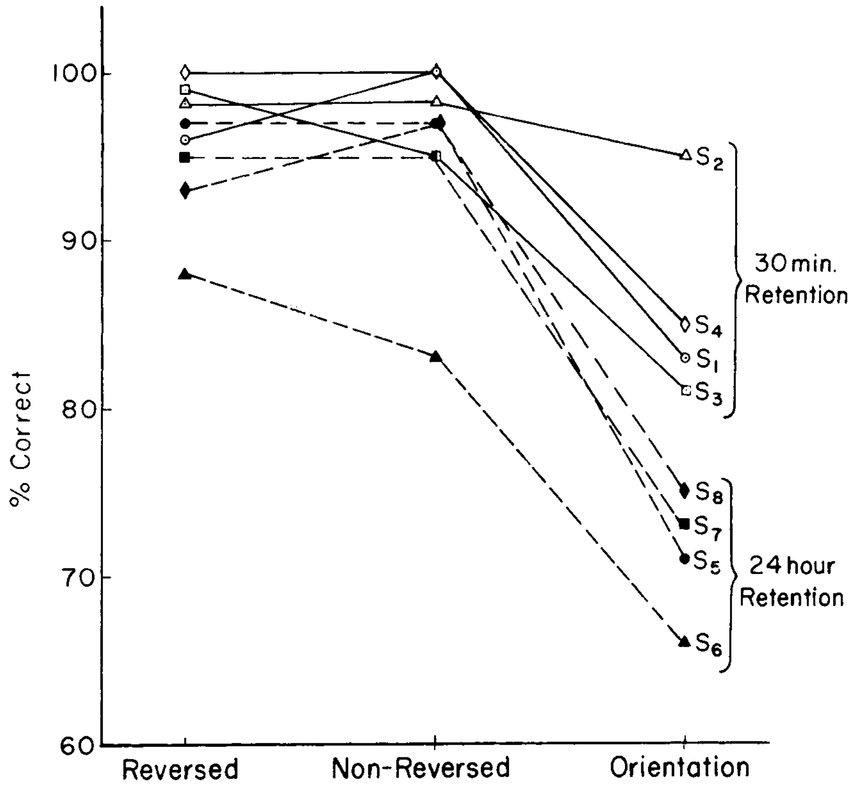

Fig. 1. Per cent correct judgment of the 120 old and 120 new pictures in the fourth experiment, as a function of retention interval, whether the test picture was reversed from its original showing, and whether the orientation was correctly remembered. The per cent correct orientation judgments are calculated on the basis of only those trials where the test stimulus was identified correctly.

than could have been inferred from his study. Since high performance was maintained on both colored and black-and-white pictures, under different exposure durations, and for both magazine photos and snapshots, it is clear that the phenomenon under study is robust and does not require a set of special conditions. (The grueling nature of the longer experimental sessions indeed insured that conditions were far from ideal). It is certain that the bounds of picture memory, if any do exist, must be very high indeed. It is certainly much higher than for memory of names (Paivio, Rogers, & Smythe, 1968).

The data of the second experiment also show that retention of the material over several days is easily accomplished, thus confirming the conclusions of Nickerson (1968). The slight primacy effect may be real or due to fatigue. In either case, errors are so few that it is difficult to speculate on their causes. In fact, no common features to any of the errors could be ascertained. It is perhaps surprising that sizable interference did not occur between certain types of very similar pictures. For example, the 2,560 stimuli contained 300 pictures of single adult male figures and 200 single female adults. Goldstein & Chance (1968) have shown that picture memory is fairly poor when 84 similar pictures of human faces are used. The present results seem to imply that their findings must be due to common visual cues rather than to common subject matter among the pictures.

Since the test stimuli that were reversed before the recognition task in the third and fourth experiments were as easy to recognize as those that were not, it appears likely that the stored representation of visual stimuli can readily be recoded to enable some form of comparison with the test stimuli. This is in accord with previous (e.g., Dallet, Wilcox, & D'Andrea, 1968; Hochberg & Galper, 1967) experiments. However, some representation of the original picture is also apparently preserved, since, although no Ss in the fourth experiment were able to identify correctly the orientation of the test stimuli on all of the recognition trials in which they had correctly recognized the test stimulus, they were well above chance level of 50% success.

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NOTES

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