Short-term sequential memory for pictures and words*

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Pictures, concrete nouns, or abstract nouns were presented sequentially at rates of 5.3 or 2 items/sec, the faster rate being designed to prevent implicit labeling of pictures during input while permitting pictures to be recognized and words to be read. Sequential memory was tested by means of a serial reconstruction task. Consistent with previous findings for immediate memory span, sequential memory was better for words than for pictures at the fast but not at the slower rate. The results further support a theory that distinguishes between imaginal and verbal memory codes, partly in terms of their relative capacity for storing sequential information.

Pictures are generally remembered better than words in nonsequential memory tasks such as free recall and recognition memory (for a review, see Paivio, 1971). However, pictures are inferior to words in a sequential memory task (immediate memory span), particularly when the rate of presentation is so fast that Ss are unable to name the pictures implicitly during input (Paivio & Csapo, 1969). These contrasting effects can be interpreted in terms of the relative availability of imaginal and verbal memory codes and differences in their functional attributes. Easily named pictures are favored in regard to the availability of the two codes, since pictures can be readily stored in a nonverbal form and are likely to be implicitly named as well, whereas words (even concrete ones) are relatively less likely to be stored as nonverbal images. Both coding systems are functionally efficient for the storage of item information, but they differ with respect to the way such information is organized. Visual imagery is specialized for parallel processing in the spatial sense, i.e., images are organized spatially, not temporally or sequentially, and the system is accordingly inefficient for storing the sequential order of pictorial units. Conversely, the verbal system is specialized for sequential processing, and storage of order is therefore efficient in the case of linguistic units. The analysis suggests that pictures will be superior to words in nonsequential memory tasks at presentation rates that permit the former to be implicitly named and will not be inferior to words even at fast rates, since item information can be retrieved from either code. However, the verbal code is essential for the retrieval of order information, and pictures, therefore, will be inferior to words in sequential memory tasks when the rate of presentation exceeds implicit labeling speed for pictures but does not exceed implicit reading speed for words. It should be noted especially that the theory predicts both positive and negative effects for pictures, depending upon specified task conditions.

While the results obtained by Paivio & Csapo (1969) were consistent in almost every detail with predictions from the theory, their sequential short-term memory (STM) task, immediate memory span, required overt verbal responding. It is uncertain, therefore, whether the inferiority of pictures in that task was due to inefficient sequential storage of pictorial information or to the difficulty of ordered verbal output during recall. The present study accordingly investigated sequential memory for pictures, concrete words, and abstract words, using a serial reconstruction task which does not require a verbal response during the recall test.

METHOD

Experimental Design and Subjects

The design was a 2 by 3 factorial in which the variables were presentation rate (fast or slow) and stimulus attribute (pictures, concrete words, abstract words). All treatment conditions involved independent groups. Forty-eight undergraduate university students served as Ss, eight Ss in each cell.

Material

The stimulus words were nine concrete (C) and nine abstract (A) nouns selected from the Paivio, Yuille, & Madigan (1968) norms. The two classes of words were approximately equated on meaningfulness (m), the means being 6.66 and 6.13 for C and A words, respectively, and word frequency (Ms = 46.3 and 44.2). However, the C items exceeded the A items in mean rated imagery (I) (6.64 vs 3.40) and concreteness (C) (7.02 vs 2.09). The nine pictorial (P) items were single-line black ink drawings of the objects labeled by the concrete words. The words were printed in black uppercase block letters. For study trials, the items were photographed on 8-mm movie film in such a manner that both the pictures and the words occupied approximately the same area. Eight trials for each stimulus type and rate were programmed on the film so that, for both rates, one movie frame was used for each stimulus item, exposing the item for .063 sec when projected at a rate of 16 frames/sec. For the fast rate, two blank frames followed each stimulus frame, while for the slow rate, seven blank frames followed each stimulus, resulting in total interitem intervals of .188 and .5 sec for the two rates. These rates were selected on the basis of previous research (Paivio & Csapo, 1969) to be such that pictures could be implicitly labeled at the slow rate but not at the fast rate. They could be easily recognized, however, and words implicitly read even at the fast rate. A different random sequence of the nine items was used on each trial. Projection was by means of a Technicolor 200-A 8-mm continuous filmstrip projector.

For test trials, the nine items of each stimulus attribute were reduced in size and glued on 2 x 2 x 1/8 in. Masonite blocks. An 18-in.-long metal stand with a 45-deg tilting face was provided for the reconstruction task.

Procedure

Each S was assigned randomly to

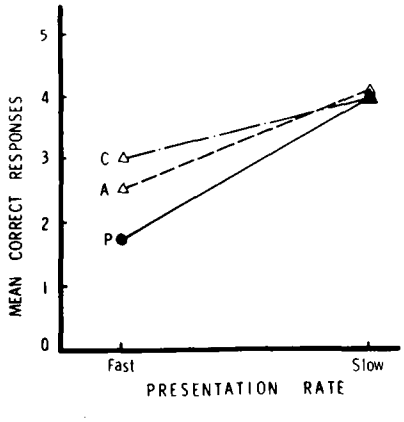

Fig. 1. Mean number of correct responses per trial per S for pictures (P), concrete nouns (C), and abstract nouns (A) under fast (5.3 items/sec) and slower (2 items/sec) rates of presentation. The standard deviations corresponding to the six means ranged from 0.34 to 0.70.

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one of the six experimental conditions: fast rate, P, C, or A; slow rate, P, C, or A. Eight Ss served in each condition. The S was seated behind a small table, 5 ft from a 2 x 3 ft screen. The nine stimulus-item blocks were placed on the table in front of the S in a prearranged 3 by 3 matrix, with the stand behind the blocks. The configuration of the matrix was consistent from trial to trial. The S was told that on each one of the eight trials, the nine items would appear in a different order on the screen and that following each presentation, he had 30 sec to put all the items on the stand in exactly the same order as they were presented on the screen, where a left-to-right spatial arrangement corresponded to a forward sequence. An oral "ready" signal and a red diamond-shaped signal preceded each trial. During a 30-sec intertrial interval, E gave the S a new set of blocks and recorded the position of each item and the number of correct placements for the previous trial.

RESULTS AND DISCUSSION

Reconstruction scores (i.e., number of correct serial placements) were analyzed by a 2 by 3 by 8 analysis of variance, with rate, stimulus attribute, and trials as factors. Confirmation of the hypothesis that sequential memory for P stimuli will suffer at the fast but not the slower rate calls for a significant Rate by Stimulus Attribute interaction. This interaction was significant, $F(2,59) = 6.89$, $p < .01$, and Fig. 1 shows that the pattern of the interaction is precisely as predicted. That is, P stimuli were inferior to words at the fast rate, but the differences were obviously negligible at the slow rate. The pattern also agrees generally with the results previously obtained for immediate memory span (Paivio & Csapo, 1969).

Also significant from the analysis were the three main effects. The rate effect, $F(1,59) = 127.06$, $p < .001$, reveals that performance was generally poorer at the fast rate. The effect of stimulus attribute, $F(2,59) = 7.33$, $p < .01$, was completely qualified by the double interaction already described, i.e., the effect is limited to the fast rate. The trials effect, $F(7,378) = 3.57$, $p < .01$, reveals that performance improved from the first to the third trial and then leveled off, presumably reflecting a general task-practice effect.

These results are completely in accord with the dual coding theory, which assumes, in part, that verbal and imaginal symbolic systems are functionally distinguished in regard to their capacity for sequential information processing (Paivio, 1971). It is difficult to see how contemporary models of memory (see Norman, 1970) could handle the contrasting results for pictures and words observed in sequential and nonsequential memory tasks without similar assumptions. In particular, the prevailing conceptualization of short-term memory as an auditory-motor-linguistic store cannot account adequately for all features of such data, although it apparently suffices to explain immediate sequential memory, even when the items are pictures.

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