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The role of verbal codes in the serial recall of pictures

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Serial recall for familiar pictures having either monosyllabic or polysyllabic labels was tested in three experiments. Experiments 1 and 3 tested the effects of picture label length and rate of presentation (slow, medium, and fast) on serial recall. In Experiment 1, subjects had practice in assigning labels to the pictures prior to the test for serial recall, whereas in Experiment 3 they did not. Both experiments showed that serial recall varies inversely with label length and rate of presentation. Experiment 2 compared the effects of prior labeling practice with no prior labeling practice on the serial recall of the two types of pictures. Prior labeling practice had no effects on serial recall and serial recall of the pictures again varied inversely with the length of the picture labels. The results of all three experiments were incorporated as support for the hypotheses that verbal codes mediate the serial recall of pictures.

The dual coding hypothesis (Paivio, 1971; Paivio & Csapo, 1969) states that stimulus information can be encoded for storage in either or both of two ways: an imaginal memory code or a verbal memory code. Further, the hypothesis asserts that visual imagery is specialized for parallel processing in a spatial sense, but not for temporally sequenced processing. In contrast, the verbal coding system is specialized for sequential processing because of the sequential characteristics of the auditory-speech system. Verbal codes, therefore, are more useful for storing sequential information than are imaginal codes. Paivio and Csapo (1969) have shown that increasing the rate of sequential presentation reduces serial recall more for pictures than for concrete or abstract words. They argued that increasing the rate of presentation interfered with the verbal coding of pictures more than that of words, because words can be read faster than pictures can be labeled.

Del Castillo and Gumenik (1972) found that accuracy of serial recall of temporally sequenced familiar pictures at both slow and fast presentation rates was superior to serial recall performance with unfamiliar forms (random shapes). This result was interpreted as consistent with the dual coding hypothesis, since verbal labels were presumed to be relatively more available for familiar than for unfamiliar shapes. A second experiment demonstrated that increasing exposure to the forms through repeated study-test trials reduced the difference in accuracy of serial recall between the familiar and unfamiliar forms, at least at the slowest presentation rate. Presumably, the additional exposure to the unfamiliar forms allowed subjects to develop verbal codes that could be employed during serial presentation.

Nelson, Brooks, and Borden (1973) approached the problem by manipulating characteristics of the verbal codes. Their results showed that serial recall of pictures was poorer when the sequences contained pictures having labels that were high in intralist phonemic similarity than when they contained pictures whose labels were low in phonemic similarity. They interpreted this result as consistent with the hypothesis that retention of a temporal sequence requires the availability of verbal codes for the sequence items.

Unfortunately, there is another possible interpretation of their results. It is possible that serial-order information is carried by both imaginal and verbal codes and that confusion among the similar verbal codes resulted in competition between the inaccurate serial information contained in the verbal codes and the more accurate serial information coded by the imaginal representation. What is needed then, is a test in which the availability of verbal codes is manipulated through variations in the characteristics of the verbal code.

EXPERIMENT 1

Experiment 1 was designed to more directly investigate the role of verbal encoding processes in the serial recall of pictures through manipulation of the length of the verbal codes and the rate of presentation. It was assumed that labels having multiple syllables take longer to produce covertly than labels having only one syllable, just as they do when produced overtly. Hence, it was predicted that if subjects employ implicit verbal codes to store sequence information, subjects shown sequences of pictures having monosyllabic labels would more accurately recall the serial order than those shown sequences of pictures having polysyllabic labels. Speed of presentation was also manipulated, since too fast a presentation rate might preclude any verbal encoding, while too slow a rate might allow more than sufficient time for

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verbally encoding both types of pictures. If verbal coding plays no role in learning the temporal order of pictures, then serial recall should not differ for the two types of pictures.

Method

Materials. The stimuli consisted of four lists of 12 black-and-white line drawings. Two of the four sets were pictures of familiar objects having monosyllabic labels: frog, wolf, bat, fish, deer, snail, ape, snake, duck, crab, mouse, whale; and cheese, soup, corn, cake, ham, pear, bread, eggs, pie, steak, grapes, clam. The other two sets were familiar pictures having polysyllabic (three or more syllables) labels: buffalo, caterpillar, pelican, dinosaur, grasshopper, rhinocerous, centipede, anteater, butterfly, elephant, porcupine, alligator; and strawberries, spaghetti, celery, banana, tomato, casserole, watermelon, artichoke, potato, ravioli, asparagus, cucumber.

Each of the pictures composing each of the four lists was photographed on both 35-mm black-and-white film and Super-8-mm black-and-white movie film. The 35-mm negatives were used to make black-and-white slides and to make 7.62 x 7.62 cm prints of each picture mounted on heavy cardboard of the same dimensions. Typewritten labels corresponding to each of the pictures were also prepared as 35-mm slides.

Subjects and Design. One hundred and twenty-seven introductory psychology students served as participants for extra course credit in a 2 by 3 between-groups factorial design. There were two types of stimuli: pictures having monosyllabic labels (monosyllabic pictures), and pictures having polysyllabic labels (polysyllabic pictures), and three rates of serial presentation, slow (1 item/sec), medium (2 items/sec) and fast (3.5 items/sec). Twenty subjects were assigned in block random order to each of the six experimental conditions. Half of those assigned to the monosyllabic conditions were given one of the two monosyllabic picture lists and half the other monosyllabic picture list. The same procedure was employed for the two polysyllabic picture lists. Seven subjects did not complete the experiment, were dropped, and replaced: four for failing to reach the required criterion in labeling practice with the monosyllabic condition, and two because of apparatus failure.

Procedure. The experiment was conducted in two parts. First, a labeling practice stage, during which subjects practiced overtly anticipating the names of the pictures used in the experimental condition to which they were assigned. This stage was employed to increase the likelihood that, if subjects used verbal codes in the subsequent serial learning task, they would use the labels agreed upon by the experimenters and other judges as most appropriate for the drawings. Furthermore, since label practice continued until subjects could anticipate all labels without error, equal availability of monosyllabic and polysyllabic labels was insured. This could not have been accomplished by simply matching the labels according to word-frequency norms, since it is not availability of the labels per se, but availability in the presence of the appropriate pictures which is relevant to the subsequent serial learning stage, in which the subjects were required to learn the order of presentation. In both stages of the experiment, subjects were seated at a table facing a wall-mounted screen approximately 1.2 m away.

During the labeling practice stage of the experiment, the 12 pictures of a set were projected on the screen one at a time for .5 sec, followed by an interval of 1.5 sec of label exposure. The interval between each picture-label pair was .5 sec. Four different random orders were used for each set. Subjects continued label practice until they had responded correctly to each of the 12 pictures on a single cycle of the list. Subjects failing to reach the criterion of one perfect cycle by the end of the 12th cycle were dismissed from the remainder of the experiment. None of the four random orders of the pictures was the same as the order of picture presentation used during serial learning.

During the second stage, the serial learning stage of the experiment, subjects were instructed that they would see only pictures, and that their task was to learn the order in which the pictures were presented. The sequence was projected on the screen by a Technicolor 200-A, Super-8-mm continuous loop movie projector. Depending upon the experimental group, the sequence was projected at either a slow, medium, or fast rate. The rate of presentation was controlled by the spacing between the frames on the movie. At all three rates, each of the 12 pictures occupied one frame on the film loop and each was exposed for 56 msec. The slow, medium, and fast rates were 1 item/sec, 2 items/sec, and 3.5 items/sec, respectively. Preceding each cycle, the word "ready" appeared on the screen for 2 sec, followed by a blank screen for .5 sec before the first picture in the sequence. At the end of the cycle of 12 pictures, the screen was blank for .5 sec before the beginning of the next cycle. After seeing two complete cycles of the film loop, the projector was turned off and the subject rested for 30 sec, during which the experimenter recorded the data from the previous test trial and randomized the test cards. After 30 sec, the experimenter turned on the room lights and gave the subjects the cards with the pictures in a random order different from that on the film loop.

The subjects were given 60 sec to arrange the cards in the correct order. Immediately afterward, the experimenter picked up the cards in the order constructed by the subject. The film loop was then presented for two more cycles followed by a 30-sec rest period and then another test. The alternation between study and test trials was continued until the subject had arranged all of the pictures correctly or until he had received eight test trials, whichever occured first. No feedback regarding the accuracy of performance on test trials was given at any time.

Results

The mean total errors on the serial recall task as a function of label length and rate of presentation are shown in Table 1. A 2 by 3 analysis of variance (MSe = 168.83) of these data resulted in statistically reliable main effects for label length and rate of presentation [$F(1,114) = 19.23$, $p < .01$ and $F(2,114) = 31.72$, $p < .01$, respectively]. The interaction between label length and speed was not reliable [$F(2,114) = 1.42$, $p > .05$]. The most important finding of this experiment is that more errors were made in positioning polysyllabic pictures than monosyllabic pictures, a result which pro-

Table 1
Mean Total Errors in the Serial Recall Task as a Function of Type

	Experiment 1 Rate of Presentation				Experiment 3 Rate of Presentation			
Type of Picture	Slow	Medium	Fast	Mean	Slow	Medium	Fast	Mean
Monosyllabic	16.25	21.95	39.15	25.78	29.00	26.85	41.25	32.37
Polysyllabic	23.65	38.00	46.90	36.18	26.45	41.05	48.00	38.50
Mean	19.95	29.98	43.05		27.73	33.95	44.63	

vides strong support for the hypothesis that verbal codes are required to mediate retention of sequential information. Since all three rates of presentation were relatively rapid, subjects given polysyllabic pictures were at a disadvantage compared with subjects given monosyllabic pictures because polysyllabic codes take more time to produce.

EXPERIMENT 2

Although the results of Experiment 1 provide evidence consistent with the hypothesis that temporally sequenced pictures are verbally encoded, it is possible that the labeling practice given prior to the serial learning task primed the subjects to employ verbal codes on the serial task. It is conceivable that without such priming, subjects would have encoded the stimuli in some other manner. If this were the case, then there would be no reason to expect any difference in serial recall performance for the two types of stimuli. Experiment 2 was designed to evaluate this possibility by comparing serial recall for the two types of stimuli following labeling practice. Only the medium rate of presentation was employed on the serial task.

Method

Eighty introductory psychology students served as subjects for extra course credit. Twenty subjects were assigned in block random order to each of four experimental conditions in a 2 by 2 between-groups factorial design. The factors were type of pretraining (familiarization and labeling) and label length (monosyllabic and polysyllabic). The stimulus materials were identical to those employed in Experiment 1. Subjects assigned to the familiarization conditions were given a set of 12 cards, each containing one of the pictures that would be used on the serial task for their particular label-length condition. The cards were laid face up on the table in front of the subject in a random arrangement and subjects were told to familiarize themselves with the pictures for 60 sec. However, no mention was made about labeling the pictures. Subjects in the label pretraining conditions were given labeling practice in a manner identical to that described in Experiment 1.

Following pretraining, all subjects were given eight serial learning study-test trials with the same stimuli they had seen during pretraining at a rate of 2 items/sec. The serial learning procedure was identical to that employed in Experiment 1, except that only one presentation of the picture sequence was given on each study trial and all subjects were given eight study-test trials, regardless of their performance.

Results

The mean total errors on the serial recall task as a function of type of pretraining and label length are shown in Table 2. From inspection of these data, it can be seen that accuracy of serial recall was again higher for monosyllabic pictures than for polysyllabic pictures regardless of the type of pretraining experience. These conclusions were supported by a statistically significant main effect for label length [$F(1,76) = 7.56$, $p < .01$]. Neither the main effect of label length, nor the interaction between type of pretraining and label length were statistically reliable [$F(1,76) = 1.42, p > .05$, and $F(1,76) < 1, p > .05$, respectively]. It is obvious from these results that subjects employ verbal codes on serial learning tasks even when they have not been primed to label the picture stimuli.

A questionnaire administered after the serial learning task indicated that nearly all subjects in all conditions used almost all of the appropriate labels for the pictures during serial learning.

EXPERIMENT 3

Experiment 3 was conducted in order to replicate the results of Experiment 1 under conditions in which no label pretraining was given and in which only one serial presentation of the list was given prior to each test of serial recall.

Method

Twenty subjects were randomly assigned to each of six experimental conditions in a 2 by 3 factorial design. The design, materials, and procedure were identical to those in Experiment 1 with the following exceptions. No label pretraining was given any of the subjects. Instead, they were given a 60-sec familiarization with the pictorial stimuli in a manner identical to that described for the familiarization conditions in Experiment 2. The serial learning task procedure was the same as that employed in Experiment 2. That is, only one presentation of the sequence of pictures was presented on each study trial and all subjects received eight serial learning tasks regardless of their performance prior to the eighth trial.

Results

Table 1 depicts the mean total number of errors in Experiment 3 as a function of label length and rate of presentation. As in Experiment 1, serial recall was poorer for polysyllabic pictures than for monosyllabic pictures [$F(1,114) = 5.18$, $p < .05$], and serial recall performance decreased as the speed of presentation increased [$F(2,114) = 13.4$, $p < .01$]. These main effects were qualified by a statistically reliable interaction between label length and rate of presentation [$F(2,114) = 3.23$, $p < .05$]. Analysis of the simple main effects for syllable length indicated that the difference between monosyllabic and polysyllabic pictures was statistically significant only at the medium rate of presentation [$F(1,114) = 9.24$, $p < .01$].

DISCUSSION

The results of the three experiments reported here convinc-

Table 2
Mean Total Errors on the Serial Learning Task in Experiment 2 as a Function of Type of Pretraining and Type of Picture

Type of Picture	Type of Pretraining: Picture Familiarization	Type of Pretraining: Labeling Practice	Mean
Monosyllabic	24.75	28.85	26.80
Polysyllabic	34.25	38.45	36.35
Mean	29.50	33.65	

ingly demonstrated that subjects require the availability of verbal codes for the efficient learning of the temporal order of a sequence of pictures. Furthermore, verbal encoding does not depend upon procedures that prime this encoding strategy. While other experiments (Colgate & Eriksen, 1970; del Castillo & Gumenik, 1972; Glanzer & Clark, 1963; Nelson, Brooks, & Borden, 1973; Paivio & Csapo, 1969) have provided evidence consistent with this explanation, none of them have done this directly by manipulating the availability of verbal codes themselves.

The evidence presented here cannot be easily interpreted within the framework of more recent theoretical developments suggesting a single abstract propositional format for internal representation of information (see Kosslyn & Pomerantz, 1977; Pylyshyn, 1973). If information is stored as abstract propositions, certainly one would not expect that accuracy of serial recall for pictures would vary as a function of the length of their corresponding labels. There is nothing about the task requirements per se in the present experiments that would necessitate the translation from a propositional representation to a verbal representation.

REFERENCES

COLGATE, R. L., & ERIKSEN, C. W. Implicit speech as an encoding mechanism in visual perception. *American Journal of Psychology*, 1970, **83**, 208-215.

DEL CASTILLO, D. M., & GUMENIK, W. E. Sequential memory for familiar and unfamiliar forms. *Journal of Experimental Psychology*, 1972, **95**, 90-96.

GLANZER, M., & CLARK, W. H. Accuracy of perceptual recall: An analysis of organization. *Journal of Verbal Learning and Verbal Behavior*, 1963, **1**, 289-299.

KOSSLYN, S. M., & POMERANTZ, J. R. Imagery, propositions, and the form of internal representations. *Cognitive Psychology*, 1977, **9**, 52-76.

NELSON, D. L., BROOKS, D. H., & BORDEN, R. C. Sequential memory for pictures and the role of the verbal system. *Journal of Experimental Psychology*, 1973, **101**, 242-245.

PAIVIO, A. *Imagery and verbal processes*. New York: Holt, Rinehart, & Winston, 1971.

PAIVIO, A., & CSAPO, K. Concrete image and verbal memory codes. *Journal of Experimental Psychology*, 1969, **80**, 279-285.

PYLYSHYN, Z. W. What the mind's eye tells the mind: A critique of mental imagery. *Psychological Bulletin*, 1973, **80**, 1-24.

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