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The Role of Implicit Naming in Pictorial Encoding

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According to the dual-code hypothesis, picture retention is enhanced when enough time is available to obtain a verbal code in addition to an image code. As a test of this hypothesis, sequences of pictures with mean naming latencies ranging from 600 to approximately 1,000 msec were presented for 110 msec each at one of five presentation rates, ranging from 110 to 1,500 msec per picture. At a rate of presentation that would not permit naming of long latency pictures, pictures with short naming latencies should show a distinct advantage in memory performance. At rates that are either slow enough for all pictures to be named or too fast for any to be named, the selective effect of naming latency should be eliminated. Both recognition memory (Experiments 1 and 2) and free recall (Experiments 3 and 4) were tested. Whereas memory performance increased dramatically when the time between pictures was increased, at no rate was a significant correlation between naming latency and memory obtained. Contrary to the dual-code prediction, implicit naming apparently was not responsible for the improvement in picture memory at slower rates.

A fundamental question in picture memory research has been the role played by naming in encoding and storage of pictorial information. The view that verbalization (implicit naming) contributes to picture memory is most clearly expressed in Paivio's (1971, 1975) dual-code model of memory. The major assumption of this model is that there are functionally distinct verbal and image memory systems that are partially interconnected. An item may be stored in the image system, in the verbal system, or in both systems. Dual storage is viewed as having an additive effect on performance. The likelihood of dual storage is considered to be greater for pictures than for words, with the result that a sequence of pictures is generally better retained than is a list of verbal labels.

An alternative view relegates verbal coding to the status of an ancillary process rather than a central component of pictorial representation. This view suggests instead that the memory representation of a picture contains both imagelike and abstract conceptual components (Nelson, Reed, & Walling, 1976; Potter, 1975, 1976; Potter & Faulconer, 1975). The pictorial advantage over words in memory is not attributed to the likelihood of verbal coding but to the visual and conceptual distinctiveness of pictures as compared with words.

To test these two views of picture memory, it is necessary to employ a method that will suppress the subject's ability to implicitly name pictures. To accomplish this end, Rowe and Rogers (1975) required subjects to shadow (repeat) spoken letters as they viewed pictures. Consistent with the dual-code prediction, both recognition and

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free recall decreased when subjects took part in the shadowing task. Paivio and Csapo (1969) argued that since pictures take longer to name than do written words, verbal coding of pictures can be selectively suppressed if a sufficiently rapid rate of presentation is employed, resulting in a reduction of pictorial superiority. They tested this prediction by presenting a sequence of pictures or written names at rates of 188 and 500 msec per item. Subjects claimed to be able to name pictures only at the slow rate, although they could read the words at both rates. As predicted, a selective decrease in recognition and recall was obtained for pictures at the faster rate.

One problem in these studies is that the procedures intended to control the naming process might have affected other encoding processes as well, for example, by interfering with visual or conceptual coding. Although intended as a means of controlling implicit speech, shadowing may have served to reduce the overall level of attention allocated to each picture. A slower presentation rate (~~which in the Paivio and Csapo, 1969, study included an increase in exposure duration per picture as well~~) may have led to more complete nonverbal encoding of pictorial details. The written words may not have benefitted as profoundly under these conditions because they are less detailed than the pictures.

A new test of the dual-coding hypothesis is employed in Experiments 1–4. The test makes use of the fact that pictures vary systematically in the speed with which they can be named. Even when subjects agree on an appropriate name, there exist sizable and consistent differences in naming latency among pictures. The primary source of this variation has been attributed to lexical retrieval, reflecting such variables as word frequency (Oldfield & Wingfield, 1965; Wingfield, 1967, 1968) and the age at which the word was acquired (Lachman, Shaffer, & Hennrikus, 1974), rather than differential difficulty in identifying a picture (Wingfield, 1968).

In the present experiments, pictures that vary in naming latency but have equivalent visual duration threshold were presented for 110 msec each, followed by a blank stimulus-off time. It was assumed that the availability of a verbal code would vary systematically with naming latency but that the availability of visual information would not. Sequences of these pictures were presented at rates ranging from one picture every 110 msec to one picture every 1,500 msec. The rationale was that prior to onset of the next stimulus in the sequence, at the slowest rate each picture could be named, at the fastest rate no picture could be named, and at the intermediate rates only some pictures could be named. According to the dual-code hypothesis, a systematic relationship between naming latency and picture retention should be obtained at one or more of the intermediate rates because only the short-latency pictures would benefit from dual coding. If, however, the benefit from increased stimulus-off time is not the result of verbal coding, then no effect of naming latency should be obtained at any of the presentation rates.

Stimulus Selection

Two groups of subjects were used to obtain pictures with similar duration thresholds and high subject agreement on a name but a wide range of naming latencies. The initial stimulus pool consisted of 252 color magazine photographs. Extraneous details were generally cut out, leaving one or two main objects on a plain gray background. Color slides were made of these pictures. Subjects in the first group of 30 undergraduates individually viewed the pictures presented by a projection tachistoscope (described in Experiment 1). Each picture appeared for 110 msec and was preceded and followed by a gray field. Subjects were instructed to name the picture as quickly as possible, using only one or two words; naming latency was recorded. There was a 7-sec delay between pictures and a warning tone was presented .5 sec before each picture.

The 106 pictures that at least 80% of the subjects named using the same label were presented to a second group of 16 under-

Table 1
Picture Name (PN) and Mean Naming Latency (MNL) in msec for Pictures in the Three Stimulus Sets

Set 1		Set 2		Set 3	
PN	MNL	PN	MNL	PN	MNL
apple	600 (98)	eyes	639 (117)	car	637 (91)
shoe	660 (102)	watch	660 (97)	butterfly	661 (137)
typewriter	686 (118)	pipe	691 (122)	chair	682 (132)
tire	703 (117)	balloon	726 (152)	shoes	698 (183)
truck	738 (146)	camera	744 (147)	flag	742 (119)
bottle	750 (154)	pens	752 (180)	sock	758 (188)
man	790 (215)	man	816 (195)	snowman	799 (107)
violin	846 (206)	vacuum	838 (168)	calculator	848 (399)
clock	854 (236)	clock	848 (251)	tractor	880 (177)
piano	870 (217)	soldier	889 (152)	suitcase	894 (257)
lighter	939 (259)	tomato	948 (310)	stove	941 (219)
skeletons	994 (268)	bicycle	973 (351)	projector	1312 (355)

Note. Standard deviations are in parenthesees.

graduates for visual duration threshold measurements. A picture was first shown for 5 msec, preceded by and followed by a medium-gray field. If the picture was not correctly identified on the first exposure, the duration was increased (by 5 msec steps to 60 msec, by 10 msec steps to 150 msec, by 100 msec steps to 450 msec, and finally to 1 sec). The name given by the subjects in the naming group was defined as the *correct response*. Duration thresholds that were beyond three standard deviations from a subject's mean were eliminated from the analysis (less than 2% of the data). The overall mean visual duration threshold was 12.7 msec (SD = 10.4 msec); the median visual duration threshold was 8.7 msec. For individual pictures, the mean ranged from 5.0 msec to 51.7 msec.

A small correlation was obtained between mean naming latency and visual duration threshold (.30), which is comparable to results reported by Wingfield (1968). This correlation was eliminated by selecting stimuli (for the present experiments) that did not differ in visual duration threshold, although they represented a range of mean naming latencies.

Three sets of 12 pictures each were assembled and used in Experiments 1–4. All of these pictures had mean duration thresholds between 5.0 and 6.0 msec. Within each set, the pictures represented a range of latencies separated by steps of about 30 msec. The three sets, matched with respect to mean naming latency, are shown in Table 1 along with the standard deviation for each picture. No two pictures with the same name were included in the same set.

Experiment 1

In Experiment 1, subjects viewed each picture set at a different rate of presentation. The mean overt naming latencies of the pictures were used to estimate the time required to make an implicit naming response (cf. Landauer, 1962). The slowest rate (1 picture per 1,500 msec) was intended to allow for implicit naming of all the stimuli; the medium rate (1 picture per 730 msec) was intended to create naming difficulty for approximately half of the stimuli; and the fastest rate (1 picture per 495 msec) was intended to prevent implicit naming of any of the pictures. The dual-code prediction is that a negative correlation between naming latency and retention should be obtained only at the medium rate.

Method

Subjects. Subjects were 18 Brandeis University undergraduate volunteers who were native speakers of American English and who reported normal or corrected vision.

Apparatus. Subjects were seated in an anechoic chamber approximately 60 cm from a rear projection screen. Two channels of a three-channel projection tachistoscope were used for stimulus presentation, and the remaining channel was used to project a blank interstimulus interval (ISI). The tachistoscope was driven by four Hunter Model 131c timers. An impulse to the stimulus shutter triggered a Heath digital reaction timer when response latencies were required. Vocal responses into a microphone stopped the timer. Pictures were approximately 12° × 12°.

Procedure. Each subject viewed all three sets of pictures, one at each rate of presentation. All possible orders of presentation rate were used, and order of picture sets followed a Latin Square design. Six different orders of pictures within each set were employed. Matched picture orders, with respect to mean naming latency, were used for the three sequences viewed by each subject. Two pictures from the initial stimulus pool (filler pictures) appeared at the beginning and at the end of each sequence.

A constant exposure duration of 110 msec was maintained for all stimuli. Blank ISIs were included to yield stimulus onset asynchronies (SOAs) of 1,500, 730, and 495 msec for the slow, intermediate and fast conditions, respectively. Subjects were instructed to pay attention to each picture as it appeared and to try to remember as many pictures as possible.

A serial recognition test was administered within approximately 2 min following each sequence. During that interval the slides were arranged for the test while the subject remained in the booth. Recognition of fillers was not tested. The test included the 12 stimulus pictures randomly interspersed with 12 new pictures (distractors) chosen from the stimulus pool. Each picture set was mixed with each distractor set equally often. Each picture remained on the screen for 4 sec. Subjects' *yes* and *no* decisions and response times were recorded. Instructions for the recognition test required the subject to use a strict criterion for saying *yes* and to respond as rapidly as possible.

Results and Discussion

The mean proportion of pictures recognized, corrected for guessing,[1] was .92, .83, and .73 for the 1,500, 730, and 495 msec rates, respectively. The decrease was highly significant, as indicated by a one-way repeated measures analysis of variance on arcsine transformed proportions, $F(2, 34) = 11.41$, $MS_e = 6035.06$, $p < .001$. The proportion of false alarms (incorrect *yes* responses) was low for all three rates (M = .03, .06, and .05, respectively).

Proportion correct as a function of naming latency. The proportion of subjects correctly recognizing pictures at each presentation rate, as a function of mean naming latency, is shown in Table 2. As predicted by both dual-coding and nonverbal models picture memory, no significant relationship was obtained between recognition accuracy and naming latency in the 1,500-msec and 495-msec conditions: The correlations were .12, $t(10) = .38$, and −.13, $t(10) = .45$, respectively. At the intermediate rate of 730 msec, a *negative* correlation between recognition and naming latency is predicted by the dual-code hypothesis. No such correlation was observed; instead, there was a nonsignificant *positive* correlation of .37, $t(10) = 1.26$.

To study the pattern of results for each subject, the 12 levels of naming latency were partitioned into three groups: the four pictures with the fastest mean naming latencies, the four pictures with the next fastest mean naming latencies, and the four pictures with the slowest mean naming latencies. A Friedman two-way analysis of variance by ranks (Subjects × Latency Group) conducted for each rate indicated no effect of naming latency on the number of pictures recognized at any of the rates, $\chi_r^2(2) = .53$, 3.08, and 1.19, for the slow to fast rates, respectively.

Even though no effect of naming latency on recognition was obtained, it is interesting to note that subjects' reports indicated that presentation rate did in fact affect the ability to implicitly name pictures in a manner similar to that expressed in the experimental rationale. Subjects reported that they were able to name all pictures at the slow rate, some pictures at the intermediate rate, and virtually no pictures at the 495-msec rate. The experimenter heard several subjects whispering picture names during the slow presentation, although none of these sub-

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[1] The formula used to correct for guessing was $Y_c = (TY - FY)/(1 - FY)$, in which Y_c is the corrected proportion of yes responses, TY is the proportion of yes responses to old pictures, and FY is the proportion of yes responses to distractors.

Table 2
Proportion of Stimuli Recognized as a Function of Mean Naming Latency and Rate of Presentation

Mean naming[a] latency (msec)	Stimulus onset asynchrony (msec)					
	Experiment 1			Experiment 2		
	1,500	730	495	495	275	110
625	.89	.67	.89	.89	.72	.39
660	.83	.83	.89	.78	.61	.28
686	1.00	.61	.78	.89	.33	.22
709	.89	.89	.67	.67	.72	.11
741	.94	.83	.56	.61	.61	.11
753	1.00	1.00	.78	.83	.68	.22
802	.89	.89	.61	.78	.50	.50
844	1.00	.94	.83	.72	.72	.17
861	.89	.83	.78	.56	.50	.11
884	.94	.83	.83	.56	.50	.39
943	.89	.78	.67	.89	.56	.22
1,093	.94	.89	.78	.89	.67	.28

[a] Mean naming latency taken over the three sets of pictures described in Table 1.

jects made any overt responses during the fast presentation.

Recognition response times. The mean recognition response time to make correct *yes* decisions was 837, 873, and 801 msec for the slow to fast rates, respectively. The 12 levels of naming latency were partitioned into four groups at each presentation rate for a two-way repeated measures analysis of variance on subject means. It revealed no significant main effects or interaction of naming latency and presentation rate on recognition response time ($F < 1.19$, in all cases).

Sequential interference by long latency versus short latency pictures. It could be argued that presentation rate does not suppress acquisition of a verbal code for long latency pictures, but instead the naming process continues until complete, disrupting the encoding of the next picture in the sequence. If this were the case, then successfully remembered pictures with long naming latencies should disrupt processing of the following pictures in the sequence more often than would pictures with short naming latencies. A Wilcoxon matched-pairs test on the number of times that a nonrecognized picture was preceded by a recognized picture with a short latency and the number of times it was preceded by a recognized long latency picture was computed for each presentation rate. In no case was a significant difference found.

Experiment 2

In selecting the rates of presentation used in Experiment 1, overt naming latencies were used as an estimate of the time required to make an implicit verbal response. Although naming latency presumably reflects the *relative* availability of verbal codes for particular pictures, implicit naming may require less time than overt naming. If this is the case, then the rates employed in Experiment 1 may not have been fast enough to disrupt implicit naming. For this reason faster rates, comparable to those used in the Paivio and Csapo (1969) study, were employed in Experiment 2. If verbal coding contributes to picture memory, selective disruption of memory for pictures with long naming latencies should eventually appear as presentation rate is increased.

Method

Subjects. Eighteen Brandeis undergraduates served as subjects.

Apparatus and procedure. The method was identical to that of Experiment 1, except as specified. The three picture sets used in Experiment 1 were photographed on Type A Kodachrome II 8-mm movie film. Exposure and ISI were controlled by varying the number of frames used. Only two orders of presentation of the pictures were employed, one the reverse of the other, but the rates of presentation were permuted across subjects, and each picture set appeared at each rate as in Experiment 1. The sequences were presented using a Bolex standard-speed (18 frames per second) projector. A constant picture duration of 110 msec (two frames of movie film) was maintained in all cases. Blank ISIs (the same gray field used previously) of 385 msec (seven frames) and 165 msec (three frames) and no ISI gave rates of one picture every 495, 275, and 110 msec, respectively. The size of the image on the screen was adjusted to be the same as that of the slides used in the recognition test.

Results and Discussion

The pattern of results was similar to that obtained in Experiment 1 although performance continued to decline with increased rate, as expected. It should be noted that recognition accuracy at the 495-msec rate was almost identical in the two experiments, suggesting that the two methods of stimulus presentation were equivalent.

The mean proportion of pictures recognized at each rate of presentation, corrected for guessing, was .74, .57, and .19 for the 495-, 275-, and 110-msec rates, respectively. A one-way repeated measures analysis of variance on arcsine transformed proportions indicated a highly significant effect of presentation rate on recognition accuracy, $F(2, 34) = 69.88$, $MS_e = 28{,}534.80$, $p < .001$. The proportion of false alarms was .04, .05, and .07 for the three rates, respectively.

Proportion correct as a function of naming latency. The proportion of pictures recognized at each presentation rate as a function of mean naming latency is shown in Table 2. Recognition memory for pictures did not vary systematically with naming latency. No significant correlation between the number of subjects recognizing a picture and the mean naming latency for that picture was obtained ($r = .00$, $-.02$, and .02) for the 495-, 275-, and 110-msec rates, respectively. As in Experiment 1, a Friedman analysis of variance by ranks was carried out at each presentation rate, and it revealed no difference in the number of pictures recognized at any rate ($\chi_r^2 < 1.08$, all cases).[2] Subjects reported that they could not name pictures at any of the rates.

Recognition response times. The mean response time to make correct *yes* decisions was 895, 909, and 908 msec for the slow to fast rates, respectively. A repeated-measures analysis of variance on subject means revealed no effect of presentation rate on the time taken to respond ($F < 1$). A two-way fixed effects analysis of variance (Naming Latency × Rate, collapsing over subjects) indicated that overall there was no effect of naming latency on the subject's recognition response time ($F < 1$). Because of the large proportion of recognition failures at the faster rates, the data were not sufficient for a statistical test of a possible interaction between naming latency and rate; inspection of the data (see Table 2) offers no suggestion of an interaction.

Sequential interference by long latency versus short latency pictures. Once again, Wilcoxon matched-pairs tests revealed that a picture that was not recognized was preceded equally often by long latency and short latency pictures.

In summary, no support for the dual-code prediction was obtained in either Experiment 1 or 2. Although the proportion of pictures recognized decreased dramatically as the blank time between pictures was de-

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[2] It is debatable whether an analysis of variance may be applied to a random variable that is discrete and ranges only from 0 to 4. A two-factor repeated-measures analysis was performed, however, on the number of pictures recognized in each latency group in Experiment 1 and in Experiment 2, which yielded the same results as the correlations and Friedman tests already reported. A significant effect of rate was obtained: For Experiment 1, $F(2, 34) = 10.82$, $p < .001$ ($MS_e = 6.35$) and for Experiment 2, $F(2, 34) = 76.41$, $p < .001$ ($MS_e = 57.35$), but an effect of naming latency was not obtained ($F < 1$) in both cases. An interaction was not obtained in Experiment 2 ($F < 1$), but the analysis revealed a significant interaction in Experiment 1, $F(4, 68) = 2.77$, $p < .05$ ($MS_e = 1.43$). The interaction was due to relatively good performance for medium-latency pictures at the intermediate rate, a theoretically meaningless finding. The pattern predicted by dual coding was clearly not in evidence.

Table 3
Proportion of Stimuli Recalled as a Function of Mean Naming Latency and Rate of Presentation

Mean naming[a] latency (msec)	Stimulus onset asynchrony (msec)					
	Experiment 3			Experiment 4		
	1,500	730	495	495	275	110
625	.78	.39	.50	.50	.39	.33
660	.50	.44	.33	.28	.33	.17
686	.44	.44	.28	.28	.33	.11
709	.44	.17	.28	.50	.28	.06
741	.39	.17	.22	.28	.17	.11
753	.39	.33	.33	.50	.28	.11
802	.67	.44	.39	.33	.44	.47
844	.56	.17	.28	.28	.28	.06
861	.39	.33	.39	.33	.50	.06
884	.61	.22	.11	.28	.17	.00
943	.50	.28	.33	.33	.17	.06
1,093	.56	.28	.22	.28	.17	.11

[a] Mean naming latency taken over the three sets of pictures described in Table 1.

creased—a finding that has been demonstrated several times in recent experiments (Intraub, Note 1; Tversky & Sherman, 1975; Weaver, 1974; Weaver & Stanny, 1978)—at no rate was the mean naming latency of the pictures correlated with recognition accuracy, recognition response time, or sequential probability of recognizing a picture.

Experiments 3 and 4

Paivio (1971) has suggested that when a recognition test of picture memory is employed, under certain conditions, the existence of a secondary verbal code may be superfluous because the test probe is sufficient for retrieval. On the other hand, verbal processes may be very important to free recall of the same stimuli because they facilitate retrieval of pictures in a case in which there is no external probe and the response is the picture name. Bahrick and Boucher (1968) reported that although overt naming of pictures during study did not aid recognition memory, it did improve immediate free recall. Experiments 3 and 4 parallel Experiments 1 and 2 but test free recall of each sequence instead of recognition. As before, the dual-code prediction is that at some intermediate rate of presentation differential recall of long and short latency pictures should be observed.

Method

Subjects. The subjects were two groups of 18 Brandeis undergraduates.

Procedure. The apparatus, materials, and design were exactly like those of Experiments 1 and 2, respectively, except as specified. Approximately 30 sec following each sequence, the subject was asked to begin listing as many pictures as possible, using a simple label. (In the two cases in which pictures with the same name appeared in 2 different sets, after recall, subjects were asked to specify that picture in more detail. For example, when the subject wrote "clock" the experimenter asked "what kind?" and the subject would reply "grandfather clock." All subjects were able to answer correctly.) In Experiment 3, every 15 sec the subject was asked to draw a line under the last item recalled in order to aid in a possible cluster analysis. Because subjects responded so rapidly and since so few pictures were recalled as rate was increased, a cluster analysis was not feasible and this procedure was not adopted in Experiment 4. Subjects were encouraged to continue attempting recall for at least 2 min.

Results and Discussion

Recall of the filler pictures preceding and following each sequence was not included in any of the analyses. The mean number of stimulus pictures recalled as a function of presentation rate was 6.2, 3.8, and 3.7

for the slow to fast rates in Experiment 3 and 4.2, 3.6, and 1.6 for the slow to fast rates, respectively, in Experiment 4. A Friedman two-way analysis of variance by ranks on the number of pictures recalled at each presentation rate for each subject revealed a highly significant decrease in performance as rate increased (Experiment 3: $\chi^2_r(2) = 30.01$, $p < .001$; Experiment 4: $\chi^2_r(2) = 36.54$, $p < .001$).

Recall as a function of naming latency. Recall of the six pictures with the shortest mean naming latencies in a set and recall of the remaining six pictures were compared. The mean number of long and short latency pictures recalled for the slow to fast conditions were 3.3 and 2.9, 1.8 and 2.1, and 1.8 and 1.9, in Experiment 3 and were 1.8 and 2.0, 1.7 and 1.6, and .6 and .8 in Experiment 4. Wilcoxon matched-pairs tests revealed that naming latency had no effect on the probability of recall at any rate of presentation. The proportion of subjects recalling each picture as a function of naming latency at each presentation rate is shown in Table 3. The correlations between naming latency and recall for the slow to fast rates were .01, −.33, and −.43 in Experiment 3 and −.42, −.42, and −.34 in Experiment 4. None of the correlations approached significance, $t(10) < -1.46$, for each condition. (It should be noted that even the slight tendency toward a negative correlation for all but the slowest rate is inconsistent with the dual-code prediction because the correlations do not vary systematicaly as rate is increased to 110 msec per picture.)

Although naming latency did not affect which pictures were recalled, it is still possible that at some intermediate rate naming latency may have affected the *order* of recall, presumably because those pictures that were verbally coded would be easier to retrieve. To test this hypothesis, the naming latency of the first picture recalled by the subject was compared with the mean of the naming latencies of all subsequent pictures recalled from that sequence. These means along with standard deviations and the results of separate dependent *t*-tests are shown in Table 4. As may be seen in the table, naming latency did not substantially affect the order of recall. Only at the 495-msec rate in Experiment 3 was a significant difference in means obtained; at that same rate in Experiment 4, however, the order of means is reversed.

Table 4
Naming Latency of the First Picture Recalled (NL1), Mean of the Naming Latencies of the Other Pictures Recalled (NL0), and the Obtained t *Statistic, at each Presentation Rate: Experiments 3 and 4*

Rate	n^a	NL1 (msec)	NL0 (msec)	t
		Experiment 3		
1,500	18	756	792	−1.13
730	16	764	783	.52
495	16	732	808	−2.15*
		Experiment 4		
495	17	801	787	.39
275	16	790	789	.39
110	8	756	791	−.54

[a] Only subjects recalling more than one picture have been included.
* $p < .05$.

General Discussion

The purpose of these experiments was to determine whether verbal coding is a central component of pictorial representation in memory. The results strongly favor a negative answer to this question and suggest that the dual-code model does not provide an adequate framework for understanding memory for complex, meaningful pictures. To review, the dual-code model attributes part or all of pictorial superiority in memory to the ability to store pictures in both an image and a verbal code. The deterioration of picture memory as the presentation rate of a sequence of pictures is increased is attributed in part to a reduced ability to implicitly name the pictures. The opposing viewpoint is that pictorial representation is composed of image and amodal conceptual components. Verbal coding is viewed as an ancillary process. The effect of presentation rate on picture memory is seen as the result of interference with either visual or conceptual coding of the stimulus (e.g., Potter, 1976).

These two models make different predictions regarding memory performance in the present experiments, in which the presentation rate of pictures that have similar visual duration thresholds but different naming latencies was varied. According to the dual-code view, at very slow or very rapid rates, a picture's naming latency should not affect memory performance because all of the pictures or none of the picures can be implicitly named during acquisition. However, at an intermediate presentation rate, memory for pictures with long naming latencies should be selectively impaired because these pictures are less likely to be implicitly named under rapid viewing conditions than are pictures with short naming latencies.

Contrary to the dual-code prediction, no effect of naming latency on memory was obtained at any rate. As the interval of time between stimuli was shortened, both recognition (Experiments 1 and 2) and free recall (Experiments 3 and 4) decreased dramatically, but naming latency did not affect which pictures were remembered, recognition response time, or the order of recall. In addition, no sequential effects in recognition with respect to naming latency were obtained. Particularly striking were the free recall results because, as mentioned previously, retrieval is not cued by an external probe and the response is the picture name. If implicit verbalization plays a central role in pictorial encoding (and pictorial superiority), one would expect to find some evidence that a lack of verbal coding is at least partially responsible for the large decrease in recall as rate is varied from 1,500 to 110 msec. In other words, the improvement in memory performance as stimulus-off time is increased must be due to processes other than verbal coding.

One question concerning these experiments, however, is whether the intermixing of pictures with different naming latencies in the same sequence could have eliminated the effect of naming latency. Difficulty in naming some of the pictures at a given rate might cause the subject to stop trying to name any of the subsequent pictures in the sequence. Althought this hypothesis might predict a reduced effect of naming latency, it can hardly account for the total lack of support for the dual-code prediction because subjects would experience some naming successes before experiencing enough naming failures to warrant the termination of all naming attempts. More importantly, acceptance of the explanation would relegate verbal coding to the status of an optional strategy as opposed to supporting the dual-code claim that it is an automatic and central component of pictorial encoding.

In conclusion, the alternative to dual-coding—nonverbal models that emphasize imagelike and abstract conceptual aspects of memory—may provide a more viable framework for studying memory for complex pictures. For example, increasing the available processing time for each picture may permit more visual and/or conceptual detail that is contained in a picture to be encoded in memory. Whether different types of information (e.g., properties such as form, color, orientation, and generic identity) follow different time courses of encoding is one of several questions to which future research might be directed.

Reference Note

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