Elaborative processing of pictures in verbal domains

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Four experiments were performed to evaluate the effect of semantic and nonsemantic verbal elaboration of the names of pictures on free recall, picture-name recognition, and picture recognition. Elaboration was manipulated by having subjects decide if the names of pictures contained two letters, rhymed with another word, or were appropriate in a sentence frame. Semantic elaboration of the names of pictures in sentence contexts requiring positive responses resulted in better name recall (Experiment 1) and name recognition (Experiments 1 and 2) than did nonsemantic elaborations (rhyme- and letter-identification tasks). However, the effects of elaborating pictures' names were greatly reduced for picture recognition (Experiments 3 and 4). The results are described in terms of elaborative processing after semantic access. Following initial semantic access, the names of pictures may be further elaborated. Semantic elaboration of the names of pictures typically leads to better retention than does nonsemantic elaboration. However, perceptual records about the appearance of objects may be relatively independent of orienting tasks that elaborate pictures' names.

The purpose of this research is to examine the degree to which elaborative processing of the names of pictures affects retention of the names and content of the pictures. The assumption underlying the first two experiments is that additional semantic elaboration of pictures' names leads to better retention than does additional nonsemantic elaboration. This assumption derives from the view that elaborative processing, the breadth or extent of stimulus analysis carried out within domains of processing (e.g., Craik & Tulving, 1975), will result in traces that are more distinctive, and hence, easier to retrieve than are other traces that are less semantically elaborated (Craik & Jacoby, 1979). Although some amount of semantic processing appears to be necessary prior to naming a picture (e.g., D. L. Nelson, Reed, & McEvoy, 1977; Smith & Magee, 1980), the amount of semantic processing should be greater when subjects are required to fit the name in a sentence frame than when they are required to elaborate it as an orthographic or phonological pattern. Greater semantic elaboration should facilitate memory

performance in tasks that require the retrieval of encoded meaning (e.g., Craik, 1983), and, therefore, the recall and recognition of the names of pictures should improve under conditions that encourage semantic elaboration. In effect, although rhyme and letter tasks would require some semantic analysis when the names of pictures are being studied, the information is elaborated in nonsemantic domains (Baddeley, 1982; Lockhart, Craik, & Jacoby, 1976). A sentence orienting task, however, involves elaborative processing in a context that requires greater semantic analysis than do letter or rhyme tasks. Also, in these experiments, letter and rhyme decisions should take longer than should sentence decisions due possibly to the greater amount of cognitive analyses required for the two nonsemantic tasks (cf. Craik & Tulving, 1975; Tyler, Hertel, McCallum, & Ellis, 1979; Zacks, Hasher, Sanft, & Rose, 1983), as well as potential differences in the order of access (D. L. Nelson et al., 1977). Nonetheless, it is hypothesized that the qualitative nature of the encoding task following initial semantic access will determine memory performance.

Although there is abundant evidence that semantic orienting tasks lead to reliably better memory performance on recall and recognition tests than do nonsemantic orienting tasks when verbal stimuli are the to-be-learned materials (e.g., Craik & Tulving, 1975), it is difficult to find the same effect of orienting tasks (i.e., semantic superiority) when pictures are the stimuli. In fact, due to its assumptions about the sequence of encoding operations and the superior effect of semantic encodings on retention, the results of several studies suggest that the original levels of processing framework may not be a completely adequate account of picture processing and memory (D'Agostino, O'Neill, & Paivio, 1977; Durso

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& Johnson, 1980; Intraub & Nicklos, 1985; D. L. Nelson et al., 1977).

Pictures can very rapidly, perhaps automatically, access their semantic representation. Also, it is well established that encoding a picture does not automatically involve activating its label, and conceptual processing of pictures may not require prior phonemic processing (Babbitt, 1982; Intraub, 1984; D. L. Nelson et al., 1977; Potter & Faulconer, 1975; Seymour, 1973; Smith & Magee, 1980). Research suggests that picture naming requires greater depth of processing than do some semantic tasks (e.g., picture categorization) because naming a picture occurs after some amount of prior conceptual processing (Durso & Johnson, 1980; D. L. Nelson et al., 1977; Smith & Magee, 1980). For example, D. L. Nelson et al. argue that processing the phonemic and orthographic features of a picture's label occurs near the end of processing operations. In fact, several studies report that the semantic effect on retention is eliminated or reversed from tasks that are normally considered semantic and nonsemantic (e.g., stimulus categorization and naming) when pictures are the stimuli (see D'Agostino et al., 1977; Intraub & Nicklos, 1985; Smith & Magee, 1980). These results indicate that if pictures are the stimuli, then the nature of the orienting task may be less important than the elaborative encoding and processing operations required by the task.

It is possible that the elimination or reversal of semantic encoding effects on remembering pictures' names is due to the amount of elaboration during encoding. A semantic task, such as judging category membership, may not involve as much elaborative processing as a nonsemantic task, such as judging phonemic similarity. The reason is that the semantic task may be redundant with normal automatic encoding operations when pictures are the stimuli (e.g., D. L. Nelson et al., 1977; Smith & Magee, 1980). Also, the nonsemantic task may itself require stimulus categorization as well as additional processing operations involved in responding to the task, particularly when the task involves picture naming (e.g., D. L. Nelson et al., 1977). Thus, the nonsemantic task may include the encoding operations involved in the semantic task and may also require further elaborative processing in a nonsemantic domain. The effect on retention would be to eliminate or reverse the putative semantic superiority effect when the semantic task necessarily precedes the nonsemantic one. However, one assumption guiding the present study is that, if a semantic task involves processing operations that are not also required by a nonsemantic one, then memory performance may be greater for semantic encodings. Such an effect would be due to the type of elaborative processing that follows initial semantic access.

As an alternative hypothesis, it may be argued that each task is a semantic task, because each involves semantic access. Any difference observed between the tasks may be due to different degrees of semantic elaboration rather than to elaborative processing in different domains fol-

lowing initial semantic access. Previous research with words indicate that, although different degrees of semantic elaboration (target concepts in simple and complex sentences) do affect free- and cued-recall performance (e.g., Craik & Tulving, 1975, Experiment 7), there are no differences between different degrees of semantic elaboration when target concepts are presented alone for recognition (Fisher & Craik, 1980). Thus, if the tasks differ only in the degree of semantic elaboration, there may be no differences in the probability of recognition between the encoding tasks when the pictures' names are presented for recognition. However, if it is plausible that targets in the nonsemantic conditions are elaborated in different domains than in the sentence task, there should be reliable differences between the tasks when name recall and name recognition are tested (e.g., Craik & Tulving, 1975). These hypotheses were evaluated with name-recall and name-recognition tests in Experiments 1 and 2.

Another issue is the possibility that any retrieval advantage of verbal semantic elaborations over nonsemantic ones will be based on postperceptual processing of pictures' names in verbal domains. That is, the recall and recognition advantage of semantic elaboration hypothesized in the present context may be limited to retrieving the names of pictures and not their appearances. There is substantial evidence to indicate that picture recognition improves as more information about the visual details of pictures is encoded (Loftus, 1972; Loftus & Bell, 1975; Loftus & Kallman, 1979; Potter, 1976; Potter & Levy, 1969; Tversky & Sherman, 1975). For example, picture recognition improves with longer exposure durations presumably because more information about the specific details of a picture is extracted as the duration of exposure increases (Loftus, 1972; Potter, 1976). Also, Loftus and his associates (e.g., Loftus & Bell, 1975; Loftus & Kallman, 1979) have found that picture recognition is better when subjects are encouraged to verbalize specific details during encoding than when they are merely required to examine the pictures. However, the present set of tasks involve elaborating the names of pictures in verbal domains; they do not encourage encoding specific visual details about the pictures beyond identifying their name referent. Therefore, although it is expected that picture recognition will be better for studied pictures than for new ones that are similar to the originals (Bartlett, Till, & Levy, 1980; Warren & Horn, 1982), there may be no differences between the encoding tasks in picture recognition. That is, there may be no advantage of sentence encodings on recognition tests that require discriminating visual details about previously encoded pictures, because each task may involve extracting only that amount of visual detail necessary to identify the pictures' names. Experiments 3 and 4 tested the hypotheses that there would be no significant differences between the orienting tasks in recognizing picture details and that, unlike recall and recognition of the pictures' names, picture recognition may be relatively unaffected by the nature of the verbal orienting tasks.

In each experiment, orienting questions about pictures involved deciding if the name of a picture contained two letters, rhymed with another word, or was appropriate in a sentence frame context. Each of these tasks should involve semantic analysis because they all require translating a picture into its name (e.g., D. L. Nelson et al., 1977; Potter & Faulconer, 1975; Smith & Magee, 1980). However, elaborative processing in the semantic domain should result in better memory performance for the names of pictures than should elaborative processing in non-semantic domains.

EXPERIMENT 1

The effects of the verbal name-encoding tasks on encoding reaction time, name recall, and name recognition were evaluated in Experiment 1.

Method

Subjects. The subjects were 36 University of Michigan undergraduate students who participated in the experiment for credit in their introductory psychology courses. All had normal or corrected-to-normal vision.

Apparatus and Materials. Stimuli were projected, via three Kodak carousel projectors, onto a screen located approximately 75 cm in front of the subject. The projected pictures were approximately 10 × 15 cm. The advancement of projectors and stimulus durations were controlled by Hunter interval timers (Model 111B) and Uniblitz electronic shutters.

The stimuli for all experiments were line-drawn pictures of objects selected from the category norms of Battig and Montague (1969) and the typicality norms of Rosch (1975). There was a total of 54 target drawings from six categories: appliances, clothing, furniture, tools, toys, and vehicles. There were nine instances per category. A group of 45 students in a learning and memory course provided labeling-consistency data from a set of 90 pictures. The 54 pictures selected as targets received name agreement of at least 90%. All of the target items matched the names of items in the picture-naming norms of Snodgrass and Vanderwart (1980), and there was a high level of correspondence between the measures for name agreement.

Another 27 drawings were developed from categories that were different from the target pictures. Eighteen of these served as practice stimuli and the other 9 served as controls for recency-sensitive retrieval. The 54 target items were photocopied; each picture then was colored with three Pentel color pens (No. S360-18) in combinations of blue (No. 110), brown (No. 106), green (No. 111), orange (No. 107), red (No. 102), and yellow (No. 105)¹ and photographed on Kodachrome 64 film to be made into slides. The practice and control pictures were treated in a similar manner.

One hundred eight two-letter pairs, 108 single words, and 108 sentence frames with a word missing (specified by a line in the sentence frame) were developed and photographed for the purpose of orienting the subjects to the name characteristics of the objects. The projected horizontal visual angle equaled approximately 1° for letters, 4° for words, and 12° for sentences.

Fifty-four meaningless patterned configurations were also developed and photographed to serve as visual noise masks to reduce the amount of postperceptual processing of the stimulus items. The masks were developed by randomly drawing nonsense patterns with the colored pens. The projected size of the masks was approximately 12 × 18 cm. Their "meaninglessness" was corroborated by asking several people if they were able to perceive any meaningful

pattern in the display. All judged the display to be devoid of meaning.

Design and Procedure. The subjects were tested individually and were informed that the experiment was concerned with how accurately one is able to answer questions about pictures. They were told that just prior to the picture being presented they would be shown one of three types of "questions" on the screen in front of them. They were told that when two letters appear they should understand this as a question to the effect: "Does the name of the picture that you are about to see have these two letters in it?" The subjects were told that when a single word appears they should understand this to mean "Does the name of the picture rhyme with this word?" The letters and rhymes were chosen to conform to the most frequently given name for the picture (Paivio, Yuille, & Madigan, 1968; Snodgrass & Vanderwart, 1980). The subjects were told that a third type of question they would see would be a sentence frame and that this is a question to the effect: "Does the name of the picture you are about to see make sense in this sentence?"

The orienting questions were presented for 2.5 sec. Immediately after the orienting question terminated, the target picture was exposed for 350 msec. The subjects were told that when the target picture appears, they should decide whether the picture appropriately refers to the orienting question. The subjects made their judgments by pressing either a "yes" or "no" response key. Either key terminated a clock that had begun to run at the onset of the target picture. The subjects were told that they should not sacrifice accuracy for speed in making their decisions. Following the offset of the target picture, a visual noise pattern was shown for 5 sec. The subjects were told that its purpose was to assist with terminating any further thinking about the sequence and to prepare for the next sequence of events.

The subjects were given 18 practice trials that allowed three repetitions of practice with each type of orienting question and response type to be encountered during the acquisition trials. This was followed by the 54 acquisition trials. Half of these trials required a "yes" response and half required a "no" response. The "yes" response key was on the right for half of the subjects and on the left for the other half. Nine pictures represented each of the six encoding conditions (3 orienting question types × yes-no response type). The same pool of 54 target pictures was used for all subjects, but each picture was rotated through the six conditions so that, for different subjects, a picture was presented under every possible condition. Following the 54 acquisition trials, nine encoding trials were provided to control for recency-sensitive retrieval and did not figure in the analysis.

Following the acquisition phase, the subjects were unexpectedly asked to free-recall the names of the target pictures. They were given 5 min to perform the task. The subjects were then given an unexpected name-recognition test that consisted of the names of the 54 original pictures that they had seen during encoding mixed in with 54 new distractor names. The distractors were drawn, in equal numbers, from the same categories as the original items. The subjects were randomly shown the 108 names for 2 sec each. They made "yes" and "no" response decisions as to whether a name had been earlier presented as a picture. The subjects were told to take as much time as they needed to make their decisions. Latency was not recorded for the recognition task because accuracy was emphasized over speed.

Results and Discussion

Encoding errors were judged to be responses to orienting questions that were different from the response intended by the experimenter and were not included in any of the analyses conducted. However, name-recall responses were scored as correct if the names were syn-

Table 1
Mean Median Response Latency (in sec),
Proportion Correct Recall, and Name Recognition
as a Function of Type of Encoding and Response Type in
Experiment 1, and Proportion Name Recognition in Experiment 2

Response Type	Encoding Task		
	Letter	Rhyme	Sentence
Response Latency: Experiment 1			
Yes	1.43(.10)	1.22(.12)	1.11(.07)
No	1.71(.13)	1.62(.11)	1.22(.06)
Recall Proportion: Experiment 1			
Yes	.15	.16	.26
No	.19	.18	.19
Recognition Proportion: Experiment 1			
Yes	.75	.70	.85
No	.76	.73	.68
Recognition Proportion: Experiment 2			
Yes	.65	.64	.83
No	.76	.77	.68

Note—Numbers in parentheses are mean proportion of errors.

onymous with the experimenter-provided name (e.g., “slacks” instead of “pants”).

Encoding reaction time. The mean median response latencies as a function of encoding task and type of response are presented in Table 1. An analysis of variance (ANOVA), following log transformation, indicated that letter encodings took longer than did rhyme encodings, whereas sentence encodings took the shortest times [$F(2,70) = 60.36$, $MS_e = 0.005$, $p < .001$], and that positive responses were faster than were negative ones [$F(1,35) = 32.09$, $MS_e = 0.011$, $p < .001$]. In addition, the interaction between encoding tasks and response type was significant [$F(2,70) = 9.39$, $MS_e = 0.0033$, $p < .01$]. Analysis of the interaction indicated that positive responses were faster than were negative ones for all three types of encodings [letter, $F(1,35) = 20.50$, $MS_e = 0.005$, $p < .001$; rhyme, $F(1,35) = 31.56$, $MS_e = 0.009$, $p < .001$; and sentence, $F(1,35) = 8.41$, $MS_e = 0.004$, $p < .01$], but that the differences were greater for the rhyme and letter tasks than for the sentences. Between-type-of-encoding analyses indicated that the type of encoding effect was significant for positive [$F(2,70) = 49.92$, $MS_e = 0.004$, $p < .001$] and negative [$F(2,70) = 102.54$, $MS_e = 0.004$, $p < .001$] decisions. Newman-Keuls tests revealed that positive letter ($p < .01$) and rhyme ($p < .05$) decisions took significantly longer than did sentence decisions. Letter decisions also took significantly longer than did rhyme decisions ($p < .01$). This pattern was repeated for negative responses; however, letter and rhyme encodings did not differ significantly. These data indicate that sentence decisions required less time, hence, possibly less effort or attention (cf. Craik & Tulving, 1975), than did letter or rhyme decisions. Letter decisions also may have required more effort or attention than did rhyme decisions for positive responses, but not for negative responses.

Free recall. The free-recall results are also shown in Table 1. An ANOVA revealed that the type-of-encoding

effect was significant [$F(2,70) = 5.23$, $MS_e = 0.014$, $p < .01$]. Newman-Keuls tests indicated that sentence decisions resulted in significantly better name recall than did rhyme or letter decisions ($p < .01$). There were no significant differences between the two nonsemantic encoding tasks. Phonemic encodings would be expected to result in higher memory performance than would orthographic encodings if words were the stimuli (e.g., Craik & Tulving, 1975). The present results indicate that this pattern may be different when encoding the names of pictures for orthographic and phonemic information. All else being equal (i.e., two nonsemantic tasks), the data indicate that, with pictures, the amount of encoding effort involved in an orthographic task (as measured by response latency) eliminates the typical superiority of phonemic encodings. However, the crucial comparisons between semantic and nonsemantic tasks indicate that the qualitative nature of elaborative processing will affect memory performance in favor of semantic elaborations over nonsemantic ones following initial semantic access.

Although there was not a significant effect due to type of response ($F < 1$), there was a significant type of encoding $\times$ response type interaction [$F(2,70) = 3.69$, $MS_e = 0.018$, $p < .025$]. Analysis of the interaction indicated that the type-of-encoding effect was significant for positive encodings [$F(2,70) = 8.10$, $MS_e = 0.017$, $p < .001$]. There were no differences in name recall between the encoding tasks for negative decisions ($F < 1$). Further analyses indicated that the number of items recalled from positive and negative response encodings differed for sentences [$F(1,35) = 5.09$, $MS_e = 0.019$, $p < .05$], but not for letter [$F(1,35) = 1.63$, $MS_e = 0.018$] or rhyme ($F < 1$) encodings. Negative responses involve encodings in which the encoding context and target item are incongruous and, therefore, do not form an integrated unit (Schulman, 1974). As a result, the target item does not undergo elaborative processing and memory performance may not be facilitated (cf. Craik & Tulving, 1975).

Name recognition. The recognition data also appear in Table 1. Although type of encoding was not significant [$F(2,70) = 1.41$, $MS_e = 0.03$] and type of response only approached significance [$F(1,35) = 3.97$, $MS_e = 0.023$, $.10 > p > .05$], the type of encoding $\times$ response type interaction was significant [$F(2,70) = 10.30$, $MS_e = 0.022$, $p < .001$]. The effect of positive responses was significant [$F(2,70) = 14.12$, $MS_e = 0.029$, $p < .001$]. Newman-Keuls tests revealed that sentence encodings produced significantly better picture name recognition than did letter ($p < .05$) or rhyme ($p < .01$) encodings. In addition, sentence encodings associated with positive responses resulted in better name recognition than did those associated with negative response encodings [$F(1,35) = 26.99$, $MS_e = 0.019$, $p < .001$]. Letter and rhyme encodings did not differ reliably due to response type. However, a significant effect of negative responses [$F(2,70) = 5.33$, $MS_e = 0.024$, $p < .01$] indicated that negative letter encodings resulted in better picture-name recognition than did negative sentence encodings ($p < .05$).

As predicted, the current results suggest that a picture may continue to be elaboratively processed after its name is accessed and that name recall and name recognition are affected by the nature of the processing that occurs following semantic access. Memory for pictures' names will be better when elaborative processing takes place in the semantic domain than when elaborative processing occurs in nonsemantic domains (Anderson & Reder, 1979). The fact that name recognition was greatly reduced for negative semantic encodings suggests that those items are less likely to be enriched by the nature of the orienting task or less likely to benefit from the length of time to respond to the stimulus.

The present results are consistent with those of Craik and Tulving (1975, Experiment 5). They found that a semantic encoding produced better memory performance than did a nonsemantic one, even though the nonsemantic task required more extensive encoding operations (defined in terms of encoding latency). The present results suggest that the amount of cognitive effort or attention involved in encoding information about a picture's name may not facilitate recall any more than does that found for extensive processing of the structural characteristics of words alone (Craik & Tulving, 1975).

EXPERIMENT 2

The findings of Experiment 1 showed evidence of a benefit for name recall and name recognition if the names of pictures are elaborated in a sentence context following initial semantic access. However, there was a potential flaw in the design of Experiment 1; namely, performance on the name-recognition test was confounded with name recall due to the recall test preceding the recognition test. It is possible that the difference in name recognition between the encoding tasks may be due to having previously recalled the names of the pictures. Experiment 2 removed this confound by presenting the name-recognition test without an intervening name-recall test.

Method

Subjects. The subjects were 36 Memphis State University undergraduate students who participated in the experiment for credit in their introductory psychology courses. All had normal or corrected-to-normal vision.

Materials and Procedure. The materials and procedures were identical to those of Experiment 1 except that the name-recall test was not given before the unexpected name recognition test. Another difference is that the encoding reaction times are not reported in Experiment 2 due to equipment failure that did not become known until after the data had been collected.

Results and Discussion

The name-recognition data of Experiment 2 are displayed in Table 1. There were no significant main effects for type of encoding [$F(2,70) = 2.57$, $MS_e = 2.23$] or type of response [$F(1,35) = 2.12$, $MS_e = 1.83$]. However, the type of encoding $\times$ response type interaction was significant [$F(2,70) = 18.88$, $MS_e = 1.91$, $p < .001$]. Positive sentence encodings produced signifi-

cantly better picture name recognition than did positive letter or rhyme encodings [$F(2,70) = 14.08$, $MS_e = 2.50$, $p < .001$]. In addition, sentence encodings associated with positive responses produced greater name recognition than did those associated with negative response encodings [$F(1,35) = 26.46$, $MS_e = 1.26$, $p < .001$]. Letter and rhyme encodings did not differ reliably due to response type. However, negative letter and rhyme encodings resulted in greater picture-name recognition than did negative sentence encodings [$F(2,70) = 3.99$, $MS_e = 1.63$, $p < .025$]. Also, the negative letter and rhyme encodings produced greater picture-name recognition than did positive letter [$F(1,35) = 8.63$, $MS_e = 2.09$, $p < .01$] and positive rhyme encodings [$F(1,35) = 10.65$, $MS_e = 2.30$, $p < .01$].

These data are consistent with the data from Experiment 1. In the case of positive encodings, the nonsemantic elaboration conditions benefited more by having a name-recall test precede the name-recognition test in Experiment 1. Name-recognition performance associated with semantic elaborations remained essentially the same across the two experiments, but name recognition was reduced for the two nonsemantic elaboration conditions when the name-recall test was not given before the recognition test.

Previous research has shown equal accessibility to the memory trace for elaborate and unelaborate semantic encodings when item recognition is tested independent of encoding context (Fisher & Craik, 1980). Therefore, encodings that undergo processing in the same domain but differ in the degree of additional elaborative processing conferred on the stimulus event (e.g., target concepts in simple and complex sentences) may be expected to be equally accessible when the memory test does not readily reinstate the encoding context (e.g., Fisher & Craik, 1980; Thomson, 1972). However, if encodings undergo processing in qualitatively distinct domains of encoding, both recall and recognition performance may be expected to reflect the outcome of between-domain differences in elaborative processing (e.g., Anderson & Reder, 1979; Jacoby & Craik, 1979). The results of these studies demonstrate that positive sentence encodings will result in better name recall and name recognition than will letter or rhyme encodings, which, while necessitating some semantic analysis of the picture for the purpose of identification (e.g., D. L. Nelson et al., 1977; Norman & Bobrow, 1979), require elaborative processing in nonsemantic domains. Such between-domain differences in stimulus elaboration are usually associated with differences in memory performance (e.g., Craik & Tulving, 1975).

EXPERIMENT 3

The findings of Experiments 1 and 2 suggest that elaborative processing in qualitatively distinct domains influences subsequent name-recall and name-recognition performance when pictures' names are encoded. However, encoding pictures involves both visual and ver-

bal information processing. Accessing the names of pictures is possible only after some amount of visual processing has taken place (Loftus, Hanna, & Lester, 1988; D. L. Nelson et al., 1977; Smith & Magee, 1980). Picture recognition improves as more information about visual details is extracted (e.g., Loftus, 1972; Potter, 1976). But, because encoding processes in the present study are directed to domains of processing associated with the names of pictures, the amount of visual processing may be negligible (i.e., only that amount necessary to identify the objects). That is, one might expect that, if encoding processes are directed to the names of pictures, then the recognition of pictures' visual details may not differ between the encoding tasks. Experiment 3 tested this additional hypothesis in order to determine if the encoding tasks would result in equivalent recognition of the appearance of objects.

Another issue addressed in Experiment 3 was the possibility that the design of these studies involves a simple transformation of the nominal stimulus (the picture) into a functional stimulus (the picture's name). This hypothesis implies that subjects are discouraged from treating the items as pictures and that the effective stimuli are, instead, the pictures' labels. Accordingly, the similarity between the results found in this study and typical levels of processing research (Craik & Tulving, 1975) may be due to the stimuli being treated as words rather than pictures. The hypothesis also assumes that same name distractors that differ from the original only in terms of type (different models of the concept "stove") should be as falsely recognized as distractors that closely resemble the original pictures perceptually. This possibility was also examined in Experiment 3. Additionally, name recall was tested to replicate the previous results.

Method

Subjects. The subjects were 36 University of Michigan undergraduate students who participated in the experiment for extra credit in their introductory psychology courses. All had normal or corrected-to-normal vision.

Materials and Procedure. The materials and procedures were the same as those used in Experiments 1 and 2 except that a name-recall test preceded an unexpected recognition test for the pictures. The recognition test consisted of the 54 original pictures that the subjects saw during encoding mixed in with 54 new pictures that served as distractors. The distractors were related to the original items in one of several ways. One third of them were differently named items from the same category and had the same colors as the original items. Another third shared the same name and were colored the same as the original items but were different models (e.g., different styles of the concept "chair"). And finally, the last third were identical to the original items except that the arrangement of colors and orientation were different in the distractors.

To assess recognition, the subjects were shown the 108 pictures in random order for 2 sec each. They were carefully informed about the degree and manner of similarity between the original and distractor items. The subjects were advised to take as much time as they needed to make a decision. Because of the high degree of item similarity, they were cautioned to base each of their decisions on their familiarity with the current item rather than on any decision that they may have previously made. This was done to try to prevent the subjects from feeling compelled to make a present deci-

sion based on a decision previously made rather than on their familiarity with the picture before them.

Results and Discussion

Encoding reaction time. The encoding reaction-time data are summarized in Table 2. The patterns observed in Experiment 1 are basically replicated in Experiment 3. As in Experiment 1, letter encodings took longer than did rhyme encodings, whereas sentence encodings required the shortest time [$F(2,70) = 54.50$, $MS_e = 0.004$, $p < .001$], and positive responses were faster than were negative ones [$F(1,35) = 19.60$, $MS_e = 0.011$, $p < .001$]. Also, the type of encoding $\times$ response type interaction was significant [$F(2,70) = 7.66$, $MS_e = 0.003$, $p < .01$]. Analysis of the interaction indicated that positive responses were faster than were negative responses for letter [$F(1,35) = 12.31$, $MS_e = 0.006$, $p < .01$] and rhyme [$F(1,35) = 24.13$, $MS_e = 0.007$, $p < .001$] encodings. However, unlike Experiment 1, the response types did not differ for sentence encodings.

Between type of encoding analyses indicated that letter and rhyme decisions took significantly longer than did sentence encodings for both positive and negative responses ($p < .01$). Positive letter encodings took more time than did positive rhyme encodings ($p < .01$), but there were no differences between those types for negative encodings.

Free recall. The free-recall results are also summarized in Table 2. Type of encoding only approached significance in Experiment 3 [$F(2,70) = 2.73$, $MS_e = 0.02$, $.10 > p > .05$]. Also, neither the effect of response type ($F < 1$) nor the interaction between type of encoding and response type [$F(2,70) = 1.52$, $MS_e = 0.024$] was significant in Experiment 3. However, as can be seen in Table 2, name recall seemed to be better for items associated with positive sentence encodings than for the two non-

Table 2
Mean Median Response Latency (in sec),
Proportion Correct Recall, and Object Recognition
as a Function of Type of Encoding and Response Type in
Experiment 3, and Proportion Object Recognition in Experiment 4

Response Type	Encoding Task		
	Letter	Rhyme	Sentence
Response Latency: Experiment 3			
Yes	1.24(.11)	1.12(.11)	1.06(.08)
No	1.44(.12)	1.41(.13)	1.07(.06)
Recall Proportion: Experiment 3			
Yes	.22	.21	.30
No	.24	.21	.23
Recognition Proportion: Experiment 3			
Yes	.59	.65	.64
No	.66	.65	.58
Recognition Proportion: Experiment 4			
Yes	.59	.61	.63
No	.69	.69	.61
False Alarms: Experiment 4			
Yes	.27	.23	.26
No	.28	.29	.25

Note—Numbers in parentheses are mean proportion of errors.

semantic conditions. Separate analyses were conducted on positive and negative response encodings because ANOVAs are fairly insensitive to a single deviant condition buried among other nonsignificantly different conditions. Also, separate analyses of positive and negative encoding trials are typically conducted in levels of processing studies because type of encoding responses often have independent effects on memory performance (e.g., Craik & Tulving, 1975). To examine this possibility, separate one-way ANOVAs were conducted (an alpha level of $p < .01$ was used for this analysis). There was a marginally significant effect associated with positive encoding types [$F(2,70) = 3.66$, $MS_e = 0.023$, $.05 > p > .01$]. There were no significant differences associated with negative responses ($F < 1$).²

Picture recognition. The recognition data are also summarized in Table 2. There were no significant main effects due to type of encoding [$F(2,70) = 1.01$, $MS_e = 0.025$], response type ($F < 1$), or for the interaction between type of encoding and response type [$F(2,70) = 2.10$, $MS_e = 0.038$]. Separate analyses of positive responses indicated that there were no significant differences between encoding types associated with making "yes" decisions [$F(2,70) = 1.36$, $MS_e = 0.052$]. However, separate analyses of negative responses revealed a significant effect due to making "no" decisions [$F(2,70) = 6.30$, $MS_e = 0.011$, $p < .001$]. Newman-Keuls tests showed that pictures associated with letter encodings were better recognized than were pictures associated with sentence encodings when negative decisions were required ($p < .05$). There were no significant differences between rhyme and sentence encodings when a negative decision was required.

False Alarms. The mean number of different types of the subjects' false positive responses are reported in Table 3. As can be seen in the table, the subjects were more likely to make false positive responses to items that closely resembled the original picture. An ANOVA confirmed that there was a significant effect due to type of distractor [$F(2,70) = 159.94$, $MS_e = 0.006$, $p < .01$]. Newman-Keuls analyses showed that the number of false positive responses were greatest to objects that were identical to the original except for changes in color and orientation and next greatest for distractors that shared the same name as the original object. All of these differences were significant ($p < .01$).

Further analyses were conducted on distractors that preserved the name of the original items. There were no

significant differences between the encoding tasks and response types in the tendency to select distractors that were identical to the originals except for changes in orientation and location of colors ($F_s < 1$). Also, the interaction between type of encoding and response type was not significant [$F(2,70) = 2.23$, $MS_e = 0.014$]. Similarly, there were no significant differences between encoding tasks and response types from distractors that shared the same name but differed in style from the original items ($F_s < 1$).

The data of Experiment 3 partially support the hypothesis that differences between the encoding tasks in retaining perceptual information about the pictures will be absent. However, the results show that there are some differences in picture recognition between the encoding tasks. Letter encodings were better than sentence encodings if a negative response was required. It is interesting to note that significantly more time is required to make negative responses to letter and rhyme encodings than to sentence encodings. Speculatively, more encoding of pictorial details may occur during the poststimulus interval for pictures associated with longer response latencies (e.g., Graefe & Watkins, 1980; Loftus & Kallman, 1979; Watkins & Graefe, 1981; Watkins, Peynircioglu, & Brems, 1984).

The data clearly suggest that the subjects did attend to more than just information about the names of items as evidenced in the greater likelihood of falsely recognizing as old those objects that most closely resembled the original pictures in terms of perceptual attributes. The results also suggest that perceptual information about the pictures was retained and that this information was used in trying to recognize the original pictures. Thus, the results suggest that the functional stimuli were not only the pictures' verbal labels but that some of the perceptual characteristics of the pictures were also encoded.

However, it is possible that the recognition test was not a sensitive test of picture memory, because the distractors so closely resembled the target picture. The distractors were sometimes identical to the original pictures except for a change in the location of colors and the spatial orientation of the picture. Those distractors may have decreased sensitivity to the original pictures due to their high similarity and, therefore, reduced the likelihood of finding significant differences between the encoding tasks. It is possible that there will be differences between the encoding tasks if the picture recognition test includes only distractors that are different exemplars of the depicted concept. Experiment 4 tested this possibility by using only those distractors that preserved the names of the original pictures but differed from the originals in style.

EXPERIMENT 4

Method

Subjects. The subjects were 36 Memphis State University undergraduate students who participated in the experiment for extra credit in their introductory psychology courses. All had normal or corrected-to-normal vision.

Table 3
Means and Standard Deviations of Types of False Alarms
Made to Object Recognition in Experiment 3

Type of Distractor	<i>M</i>	<i>SD</i>
Same object/different location of colors and orientation	9.97	2.84
Same name/different object	5.11	2.05
Same category/different object	1.31	1.33

Note—Maximum cell entry is 18.

Materials and Procedure. The materials and procedures were the same as those used in Experiment 3 except that the encoding reaction times are not reported due to equipment failure that did not become known until after the data had been collected. Also, a name-recall test was not presented before the unexpected recognition test. The distractors in the recognition test were 54 new pictures that shared the same name and were colored the same as the original items but were different models (e.g., different styles of the concept "chair"). As in Experiment 3, the subjects were shown the 108 pictures in random order for 2 sec each. Also, similar to Experiment 3, the subjects were given instructions informing them that the distractors all shared the same name as the pictures they had previously seen and that their task was to recognize the identical picture they had seen during the first phase of the experiment.

Results and Discussion

Picture recognition. The recognition data for Experiment 4 are summarized in Table 2. There were no significant differences between the encoding tasks ($F < 1$). There were significantly more pictures recognized due to making "no" decisions at encoding than due to making "yes" decisions [$F(1,35) = 4.78$, $MS_e = 0.0336$, $p < .05$]. However, as indicated by a separate analysis, this effect was limited primarily to better recognition of pictures associated with negative letter encodings over positive ones [$F(1,35) = 5.61$, $MS_e = 0.029$, $p < .025$]. The tendency for negative rhyme encodings to produce better picture recognition than positive ones only approached significance [$F(1,35) = 3.56$, $MS_e = 0.035$, $.10 > p > .05$]. The interaction between type of encoding and response type was not significant [$F(2,70) = 2.10$, $MS_e = 0.038$]. Separate analyses of negative responses indicated that the differences between encoding types associated with making "no" decisions only approached significance [$F(2,70) = 2.82$, $MS_e = 0.025$, $.10 > p > .05$].

False alarms. The false-alarm data are also displayed in Table 2. As can be seen in the table, there were no significant differences between the encoding tasks and response types in the tendency to falsely recognize distractors that shared the same name but differed in style from the original items ($F_s < 1$). The interaction between encoding tasks and response types was also not significant [$F(2,70) = 1.46$, $MS_e = 0.017$].

There is no indication in the data from Experiment 4 that the more difficult picture recognition test of Experiment 3 attenuated any differences between the encoding conditions. The proportion of correctly recognized pictures is about the same in each condition across the two experiments. Also, the results of Experiments 3 and 4 suggest that the encoding conditions typically do not differ significantly in picture-recognition performance. The results also indicate that the verbal name-encoding tasks are sensitive to the perceptual features of the target pictures. Although the orienting tasks probed information about the verbal name characteristics of the pictures, the difference between the hit rates and the false-alarm rates suggests that visual details about the target pictures were

also encoded and were used to discriminate target pictures from same-name distractors.

GENERAL DISCUSSION

Overall, the present experiments indicate that elaborating the names of pictures in verbal semantic and non-semantic contexts, after the pictures have initially accessed their semantic representation (e.g., Bajo, 1988; D. L. Nelson, 1979), have the following effects on retention: First, the recall and recognition of pictures' names are better if the names are elaborated in positive sentence encoding contexts than if the names are elaborated in contexts that require accessing their orthographic or phonemic characteristics (Experiments 1 and 2). Second, recognition of the pictures themselves was not affected by differences between semantic and nonsemantic verbal name elaborations (Experiments 3 and 4). These results pose two related theoretical questions: Why does semantic and nonsemantic elaboration affect retention of the names but not the content of the pictures, and why does picture recognition seem to be unaffected by the encoding tasks?

In many respects, the results for free recall and recognition of pictures' names are reminiscent of traditional levels of processing results (e.g., Craik & Tulving, 1975). However, the present results cannot be understood in the context of the original levels of processing framework (Craik & Lockhart, 1972), given its emphasis on the sequential, hierarchical nature of information processing that culminates in semantic processing. The verbal processing of pictures follows a different set of operations than do those typically involved in processing words. Prior to encoding and processing the lexical, phonemic, and orthographic features of the names of pictures, some amount of semantic activation is required (e.g., Bajo, 1988; D. L. Nelson, 1979; Smith & Magee, 1980). This, of course, has consequences for the hierarchical and temporal sequence proposed in the original levels of processing framework.

The present results can be understood in the context of the revised view. In the revised view (e.g., Lockhart et al., 1976), elaborative processing can take place in qualitatively distinct domains and the degree of such processing will have consequences on memory performance. Research in elaborative processing has established that meaningfulness can be a matter of degree and that more precise and elaborative processing within the semantic domain will result in high levels of retention (Johnson-Laird, Gibbs, & de Mowbray, 1978; Stein, et al., 1982; Till & Walsh, 1980). A contribution of the present study is to suggest that the names of pictures can be further elaborated in domains of processing specified by the orienting task. The results indicate that although some semantic analysis is required when naming pictures, the level of analysis may be relatively less elaborate under some conditions of encoding and processing. This outcome may occur when encoding processes are directed

to nonsemantic (orthographic and phonemic) domains of processing, as in the present study, or when semantic access is relatively automatic—for example, when encoding operations involve picture categorization (Intraub, 1984; D. L. Nelson et al., 1977; Smith & Magee, 1980). The results of the present study also indicate that initial semantic processing may have been just the amount necessary to initiate elaborative nonsemantic processing of the names of pictures when encoding orthographic and phonemic information. However, further semantic elaboration, beyond mere stimulus categorization, may have been required by the sentence-orienting task. Elaborative processing in nonsemantic domains will not yield descriptions that are as meaningful or distinct as elaborative processing in semantic domains (e.g., Anderson & Reder, 1979; Johnson-Laird et al., 1978).

What explanation can be given for the general lack of differences between the encoding tasks in picture recognition? Picture recognition improves as more information about the visual details of pictures are encoded (e.g., Loftus & Kallman, 1979; Potter, 1976). However, if different encoding activities are not specifically directed toward extracting visual details, then, perhaps, there will be no difference between the encoding activities in the retention of pictures' details. The present results suggest that visual encoding processes yielded approximately equal amounts of visual details about the pictures because the orienting tasks in these experiments encouraged processing in verbal domains that emphasized orthographic, phonemic, lexical, and propositional descriptions about the pictures' names rather than visual descriptions about the pictures' appearance. There is evidence suggesting that pictorial and verbal processing of pictures are functionally distinct processing domains that may be under strategic control, and each may independently facilitate the long-term retention of pictures (e.g., Graefe & Watkins, 1980; Proctor, 1983; Watkins & Graefe, 1981; Watkins et al., 1984). Given that the encoding tasks specified verbal domains of processing and that the subjects were not aware that memory for pictures' details would be tested, it is possible that the failure to find important differences between the verbal encoding tasks in recognizing pictures' details was due to the incidental nature of the learning test, as well as attentional constraints on the information to be encoded (e.g., Graefe & Watkins, 1980; Tversky & Sherman, 1975).

However, it is clear that visual processing domains provided some descriptive information about the pictures. This was evidenced by the above-chance performance on the difficult object-recognition test in Experiment 3. There was a significantly greater tendency for distractors to be falsely recognized when they were identical to the original pictures except for color and spatial location than when they shared the same name as the original item. Further evidence for the sensitivity of the encoding conditions to the perceptual characteristics of the picture was demonstrated in Experiment 4. The correct-recognition and false-alarm results indicate that the perceptual characteris-

tics of the original pictures could have been discriminated from same-name distractors that were different exemplars of the pictured concept. There was a tendency, however, for negative nonsemantic encodings to produce better picture recognition than did positive nonsemantic encodings; they were also better than the semantic encodings. It is not clear how to account for the trend; it was only marginally significant. Negative nonsemantic encodings require significantly more time to respond to than do all other types of encodings. It is possible that more visual details about the pictures are encoded during the post-stimulus interval for negative nonsemantic encodings because more visual updating of the pictures may be required to respond to the orienting question (see Watkins et al., 1984).

The present results are in contrast to an earlier study reported by D'Agostino et al. (1977). They found that rhyme (phonemic) and sentence (semantic) orienting tasks resulted in equivalent name-recall performance for pictures. They argued that the levels-of-processing framework should predict greater recall for pictures encoded in a semantic context than in a phonemic one. Therefore, D'Agostino et al. interpreted their results as providing evidence against a levels-of-processing account of picture encoding, but as support for the dual-coding account (Paivio, 1971). According to D'Agostino et al., the dual-coding model maintains that when verbal information about pictures is encoded, such encodings will serve to activate referential processing (i.e., processing that activates both verbal and visual codes when encoding pictures and words). Therefore, according to the dual-coding model, there should be equivalent memory performance from phonemic and semantic orienting tasks when encoding the names of pictures, because both verbal and visual codes are activated by the encoding tasks (D'Agostino et al., 1977).

However, D'Agostino et al. used a repetition procedure in which subjects saw the test item twice under the same encoding type. The case for the differential benefit of repetition as a function of encoding level and type of material has not yet been decided (Chabot, Miller, & Juola, 1976; Goldman & Pellegrino, 1977; Jacoby, Bartz, & Evans, 1978; T. O. Nelson, 1977). It could be that the effect of repetition in their study served to enhance trace accessibility for items that required some semantic processing while not changing the qualitative nature of encoding (cf. Jacoby et al., 1978). Also, D'Agostino et al.'s results for encoding latency were different from those reported in the present study. Their results indicate that encoding graphically presented names takes nearly 90 msec longer than does translating pictures into their names for positive sentence frames. Furthermore, the positive response latencies in their phonemic task were equivalent for pictures and the presented names. These results are not consistent with the fact that accessing a verbal label from a picture takes approximately 200–300 msec longer than does reading a word (e.g., Potter & Faulconer, 1975; Smith & Magee, 1980). It may be that the second presen-

tation of the pictures facilitated encoding, processing, and retrieval of the items in such a way that normally expected differences had become canceled.

The present results also have interesting implications for Johnson's (1983) recently proposed multiple-entry modular memory system. Johnson argued that, under some circumstances, target recognition may be based on perceptual records established independently of reflective activity. Johnson's *reflection* system involves the active thinking, comparing, and judging functions of cognition. It includes among its activities the process of elaboration and is specialized for the voluntary recall of information. The *perceptual* system encodes specific instances of identifiable patterns and functions to facilitate recognizing previously seen events as familiar. Free recall and recognition of the names of pictures in the present study might have involved the activity of the reflection system by elaborating the pictures' labels in the context of the encoding tasks. However, picture recognition might have been largely independent of the reflective activity involved in the orienting tasks and, instead, was based on the perceptual records established by the perceptual system as a consequence of encoding the specific pictures. Thus, although name recall and recognition were influenced by the nature of the orienting task, picture recognition was not as affected (see Morris, Bransford, & Franks, 1977).

It is important to note that picture memory may involve processing a picture's label, verbally processing the characteristics of a picture, or processing the picture per se. Processing a picture's label may have different effects on picture memory than does verbally processing the characteristics of pictures or processing the picture per se (e.g., Loftus & Kallman, 1979). Although these three are related, there may be important differences in terms of their effect on retention. It is possible that the results would be different if processing involved either visual or verbal descriptions of the pictures rather than processing of the pictures' labels (cf. Graefe & Watkins, 1980; Watkins et al., 1984; Marks, 1989).

The present results complement previous findings by providing new information about ways in which verbal name-orienting tasks may affect memory for picture names and their appearances following semantic access. Several researchers have reported greater memory performance for pictures following verbal encoding (Durso & Johnson, 1980; Smith & Magee, 1980) or processing of a picture's sensory attributes (Intraub & Nicklos, 1985) than following semantic processing. However, some semantic encodings may not provide very elaborate or distinctive descriptions of target pictures that would serve to uniquely discriminate memory records at the time of retrieval, because the semantic task is redundant with automatic encoding activities (e.g., Intraub & Nicklos, 1985). In fact, several authors have suggested that access to the semantic domain may be automatic for pictures of objects (Intraub, 1984; D. L. Nelson, 1979; Smith & Magee, 1980) or even that the categorization of pictures can

be based on visual cues alone due to feature overlap when pictures are from the same category (Snodgrass, 1984). Either way, the present results indicate that elaborative processing of a picture for its verbal, physical, or semantic characteristics, following automatic categorization of whatever sort, may provide additional levels-of-description that increases the elaboration and distinctiveness of the memory record for the item and that, thereby, facilitates its retrieval.

REFERENCES

- ANDERSON, J. R., & REDER, L. M. (1979). An elaborative processing explanation of depth of processing. In L. S. Cermak and F. I. M. Craik (Eds.), *Levels of processing in human memory*. Hillsdale, NJ: Erlbaum.
- BABBITT, B. C. (1982). Effects of task demands on dual coding of pictorial stimuli. *Journal of Experimental Psychology*, **8**, 73-80.
- BADDELEY, A. D. (1982). Domains of recollection. *Psychological Review*, **89**, 708-729.
- BAJO, M. T. (1988). Semantic facilitation with pictures and words. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **14**, 579-589.
- BARTLETT, J. C., TILL, R. E., & LEVY, J. C. (1980). Retrieval characteristics of complex pictures. *Journal of Verbal Learning & Verbal Behavior*, **19**, 430-449.
- BATTIG, W. F., & MONTAGUE, W. E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monographs*, **80**(No. 3, Pt. 2), 1-46.
- CHABOT, R. J., MILLER, T. J., & JUOLA, J. F. (1976). The relationship between repetition and depth of processing. *Memory & Cognition*, **4**, 677-682.
- CRAIK, F. I. M. (1983). On the transfer of information from temporary to permanent memory. *Philosophical Transactions of the Royal Society London*, **B302**, 341-359.
- CRAIK, F. I. M., & JACOBY, L. L. (1979). Elaboration and distinctiveness in episodic memory. In L. G. Nilsson (Ed.), *Perspectives on memory research: Essays in honor of Uppsala University's 500th anniversary* (pp. 145-166). Hillsdale, NJ: Erlbaum.
- CRAIK, F. I. M., & LOCKHART, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning & Verbal Behavior*, **11**, 671-684.
- CRAIK, F. I. M., & TULVING, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, **104**, 268-294.
- D'AGOSTINO, P. R., O'NEILL, B. J., & PAIVIO, A. (1977). Memory for pictures and words as a function of level of processing: Depth or dual coding? *Memory & Cognition*, **5**, 252-256.
- DURSO, F. T., & JOHNSON, M. K. (1980). The effects of orienting tasks on recognition, recall, and modality confusion of pictures and words. *Journal of Verbal Learning & Verbal Behavior*, **19**, 416-429.
- FISHER, R. P., & CRAIK, F. I. M. (1980). The effects of elaboration on recognition memory. *Memory & Cognition*, **8**, 400-404.
- GOLDMAN, S. R., & PELLEGRINO, J. W. (1977). Processing domains, encoding elaboration, and memory trace strength. *Journal of Verbal Learning & Verbal Behavior*, **16**, 29-43.
- GRAEFE, T. M., & WATKINS, M. J. (1980). Picture rehearsal: An effect of selectively attending to pictures no longer in view. *Journal of Experimental Psychology: Human Learning & Memory*, **6**, 156-162.
- INTRAUB, H. (1984). Conceptual masking: The effects of subsequent visual events on memory for pictures. *Journal of Experimental Psychology: Learning, Memory & Cognition*, **10**, 115-125.
- INTRAUB, H., & NICKLOS, S. (1985). Levels of processing and picture memory: The physical superiority effect. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **11**, 284-298.
- JACOBY, L. L., BARTZ, W. H., & EVANS, J. D. (1978). A functional

- approach to levels of processing. *Journal of Experimental Psychology: Human Learning & Memory*, **4**, 331-346.
- JACOBY, L. L., & CRAIK, F. I. M. (1979). Effects of elaboration of processing at encoding and retrieval: Trace distinctiveness and recovery of initial context. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 1-22). Hillsdale, NJ: Erlbaum.
- JOHNSON, M. K. (1983). A multiple-entry, modular memory system. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 17, pp. 81-123). New York: Academic Press.
- JOHNSON-LAIRD, P. N., GIBBS, G., & DE MOWBRAY, J. (1978). Meaning, amount of processing, and memory for words. *Memory & Cognition*, **6**, 372-375.
- LOCKHART, R. S., CRAIK, F. I. M., & JACOBY, L. L. (1976). Depth of processing, recognition and recall: Some aspects of a general memory system. In J. Brown (Ed.), *Recall and recognition* (pp. 75-102). London: Wiley.
- LOFTUS, G. R. (1972). Eye fixations and recognition memory for pictures. *Cognitive Psychology*, **3**, 525-551.
- LOFTUS, G. R., & BELL, S. M. (1975). Two types of information in picture memory. *Journal of Experimental Psychology: Human Learning & Memory*, **1**, 103-113.
- LOFTUS, G. R., HANNA, A. M., & LESTER, L. (1988). Conceptual masking: How one picture captures attention from another picture. *Cognitive Psychology*, **20**, 237-282.
- LOFTUS, G. R., & KALLMAN, H. (1979). Encoding and use of detail information in picture recognition. *Journal of Experimental Psychology: Human Learning & Memory*, **5**, 197-211.
- MARKS, W. (1989). *The effects of encoding the perceptual features of pictures on memory*. Manuscript submitted for publication.
- MORRIS, C. D., BRANSFORD, J. D., & FRANKS, J. J. (1977). Levels of processing and transfer appropriate processing. *Journal of Verbal Learning & Verbal Behavior*, **16**, 519-533.
- NELSON, D. L. (1979). Remembering pictures and words: Appearance, significance, and name. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory*. Hillsdale, NJ: Erlbaum.
- NELSON, D. L., REED, V. S., & McEVoy, C. L. (1977). Learning to order pictures and words: A model of sensory and semantic encoding. *Journal of Experimental Psychology: Human Learning & Memory*, **3**, 485-497.
- NELSON, T. O. (1977). Repetition and depth of processing. *Journal of Verbal Learning & Verbal Behavior*, **16**, 151-171.
- NORMAN, D. A., & BOBROW, D. G. (1979). Descriptions: An intermediate stage in memory retrieval. *Cognitive Psychology*, **11**, 107-123.
- PAIVIO, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart, & Winston.
- PAIVIO, A., YUILLE, J. C., & MADIGAN, S. (1968). Concreteness, imagery, and meaningfulness values for 925 nouns. *Journal of Experimental Psychology Monographs*, **76**(No. 1, Pt. 2), 1-25.
- POTTER, M. C. (1976). Short-term conceptual memory for pictures. *Journal of Experimental Psychology: Human Learning & Memory*, **2**, 509-522.
- POTTER, M. C., & FAULCONER, B. A. (1975). Time to understand pictures and words. *Nature*, **253**, 437-438.
- POTTER, M. C., & LEVY, E. I. (1969). Recognition memory for a rapid sequence of pictures. *Journal of Experimental Psychology*, **81**, 10-15.
- PROCTOR, R. W. (1983). Recognition memory for pictures as a function of poststimulus interval: An empirical clarification of existing literature. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **9**, 256-262.
- ROSCH, E. (1975). Cognitive representation of semantic categories. *Journal of Experimental Psychology: General*, **104**, 192-233.
- SCHULMAN, A. I. (1974). Memory for words recently classified. *Memory & Cognition*, **2**, 47-52.
- SEYMOUR, P. H. K. (1973). A model for reading, naming and comparison. *British Journal of Psychology*, **64**, 35-49.
- SMITH, M. C., & MAGEE, L. E. (1980). Tracing the time course of picture-word processing. *Journal of Experimental Psychology: General*, **109**, 373-392.
- SNODGRASS, J. G. (1984). Concepts and their surface representation. *Journal of Verbal Learning & Verbal Behavior*, **23**, 3-22.
- SNODGRASS, J. G., & VANDERWART, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning & Memory*, **6**, 174-215.
- STEIN, B. S., BRANSFORD, J. D., FRANKS, J. J., OWINGS, R. A., VYE, N. J., & MCGRAW, W. (1982). Differences in the precision of self-generated elaboration. *Journal of Experimental Psychology: General*, **111**, 399-405.
- THOMSON, D. M. (1972). Context effects in recognition memory. *Journal of Verbal Learning & Verbal Behavior*, **11**, 497-511.
- TILL, R. E., & WALSH, D. A. (1980). Encoding and retrieval factors in adult memory for implicational sentences. *Journal of Verbal Learning & Verbal Behavior*, **19**, 1-16.
- TVERSKY, B., & SHERMAN, T. (1975). Picture memory improves with longer on-time and off-time. *Journal of Experimental Psychology: Human Learning & Memory*, **104**, 114-118.
- TYLER, S. W., HERTEL, P. T., MCCALLUM, M. C., & ELLIS, H. C. (1979). Cognitive effort and memory. *Journal of Experimental Psychology: Human Learning & Memory*, **5**, 605-617.
- WARREN, L. R., HORN, J. W. (1982). What does naming a picture do? Effects of prior picture naming on recognition of identical and same-name alternative. *Memory & Cognition*, **10**, 167-175.
- WATKINS, M. J., & GRAEFE, T. M. (1981). Delayed rehearsal of pictures. *Journal of Verbal Learning & Verbal Behavior*, **20**, 276-288.
- WATKINS, M. J., PEYRIRCIOGLU, Z. F., & BREMS, D. J. (1984). Pictorial rehearsal. *Memory & Cognition*, **12**, 553-557.
- ZACKS, R. T., HASHER, L., SANFT, H., & ROSE, K. C. (1983). Encoding effort and recall: A cautionary note. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **9**, 747-756.

NOTES

1. The pictures were colored for the purpose of providing sufficient distracting information to test incidental recognition of the pictures (Experiments 3 and 4). These same pictures were used in additional research in which encoding involved visual processing of the pictures (Marks, 1989).
2. The free-recall results were replicated in another study not presented here. In that study, there was an effect due to the type of encoding [$F(2,94) = 5.69$, $MS_e = 0.017$, $p < .025$]. The effect of response type [$F(1,47) = 1.64$, $MS_e = 0.022$] and the interaction between type of encoding and response type [$F(2,94) = 2.42$, $MS_e = 0.015$] were not significant. However, further analyses did reveal that there were significant differences between types of encoding for positive response encodings [$F(2,94) = 9.99$, $MS_e = 0.012$, $p < .001$], but not for negative response encodings ($F < 1$). The mean probabilities of correct name recall were .27, .18, and .17 for positive sentence, rhyme, and letter encodings, respectively.

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