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Picture Recognition Improves With Subsequent Verbal Information

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In three experiments, subjects studied photographs presented alone or followed by a descriptive sentence. The sentence provided additional information not available in the picture. Subsequent yes–no recognition tests for the pictures demonstrated better memory for those pictures that had been followed by descriptive sentences. Experiment 1 showed that described pictures were remembered better regardless of whether comparison was to undescribed pictures presented in immediate succession or to undescribed pictures followed by a blank period equal in duration to the descriptive sentence. Experiment 2 demonstrated that although both unrelated and related sentences aided picture recognition, related sentences were significantly more helpful. Experiment 3 revealed that increasing the amount of related information (low, medium, and high) had no differential effect on picture recognition. Three explanations of these results are considered: integration of the sentence with the picture, formation of a semantic representation in addition to the pictorial one, and elaboration of the pictorial representation initiated by the sentence. Taken together, the findings seem most consistent with the elaboration account—A post-picture sentence improves attention to and perhaps rehearsal of the representation of the picture following its display.

Research on memory for pictures has increased dramatically over the past 20 years (e.g., G. R. Loftus, 1972; Mackworth & Morandi, 1967; Mandler & Ritchey, 1977; Shepard, 1967). More and more, this research has come to focus on the processes underlying picture recognition as well as on the nature of memory representations for pictures. A major concern has been to understand what happens after a picture is no longer in view. Does processing of a picture stop once it has disappeared? Initially, the answer to this question seemed to be *yes*. On the basis of experiments in which subjects were required to recognize photographs that had been presented rapidly in sequence, Potter and Levy (1969) concluded that pictures are processed for "exactly the duration of presentation" (p. 14). Shaffer and Shiffrin (1972) reached the same conclusion after demonstrating that the insertion of a period of "blank time" after each picture in a series did not lead to improved recognition accuracy. This was true despite encouraging subjects to use the interval to think about and to try to remember the previous picture. They argued that "there can be no analog of verbal rehearsal in the visual memory system that can be applied to moderately complex visual stimuli" (p. 295).

More recently, however, investigators have argued that pictures can continue to be processed even when they are no longer present. Tversky and Sherman (1975) reported improvements in both recognition and recall of pictures with increased exposure time and with increased time between pictures. Graefe and Watkins (1980) demonstrated improved recognition for a variety of types of pictures when rehearsal of one member of each pair of pictures was encouraged. This was true

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even when the pictures were nameless shapes, presumably preventing verbal rehearsal. The implication is that the pictures themselves are being rehearsed, not verbal descriptions of the pictures. Numerous other studies support these arguments (e.g., Intraub, 1979; Potter, 1976; Read, 1979; Weaver, 1974). Pictures can benefit from rehearsal.

Another line of research also has focused on post-pictorial processing, but from a different perspective. Here, the emphasis has been on whether picture memory can be influenced by verbal events that occur subsequent to the picture. As one example, Pezdek (1977) followed each of a series of pictures with a sentence. Information in picture-relevant sentences affected later picture recognition, whereas information in picture-irrelevant sentences did not affect picture recognition. Pezdek reasoned that this occurred because only relevant information would be integrated with a picture in memory. This is the *integration* hypothesis.

Much of this kind of work has been done in the context of eyewitness memory (e.g., E. F. Loftus, 1979; E. F. Loftus & Palmer, 1974). For instance, E. F. Loftus, Miller, and Burns (1978) showed subjects a sequence of slides depicting an accident, then exposed subjects to verbal information consistent or inconsistent with that in the slides. Compared with a control group that saw no additional information, consistent verbal information improved picture recognition, whereas misleading verbal information reduced performance. E. F. Loftus et al. concluded that information from the two sources was being integrated into a single memory.

Recently, criticisms of the eyewitness studies have cast the integration hypothesis into some doubt. Christiaansen and Ochalek (1983) have shown that subjects presented with post-pictorial misleading information can avoid its negative effects if they are warned that they have been misled. The warning can occur as late as 45 minutes after the original event and still be successful, suggesting that memories for both events—the pictures and the misleading verbal information—are stored separately in memory. A series of experiments by Zaragoza and McCloskey (1983) also deflates the idea of "integrated" or overwritten memories. By manipulating the form of the picture recognition test, they were able to eliminate the Loftus et al. effect despite the presence of misleading information. Although it is difficult to imagine a critical experiment on such a complex issue, these studies at least undermine the idea that the two types of information are always integrated in memory.

As it happens, much of the research relevant to how verbal processing affects memory for visual information has been carried out in the domain of memory for faces. Here, provision of supplementary verbal information while the faces are being studied has tended to improve face recognition (e.g., Klatsky, Martin, & Kane, 1982). Although the integration hypothesis could be invoked to explain this improvement, two other hypotheses also have been proposed. These offer a rather different view of what takes place when verbal information augments visual information.

Klatzky et al. (1982) showed subjects pictures of faces coupled with information concerning the occupations of the people depicted. In general, the verbally presented occupation information improved recognition of the faces. They accounted for this finding with a version of dual coding theory wherein formation of a semantic code for the verbal information supplements the already existing pictorial code for the face. In essence, improved face recognition due to additional verbal information derives from a second code. This is the *semantic code* hypothesis.

Kerr and Winograd (1982) showed people pictures of faces either with or without simultaneous verbal information about the pictured individual. Face recognition was better for faces that had some verbal information provided during encoding, but the amount of verbal information did not seem to matter. Their account used the idea of greater elaboration at encoding to explain better recognition for faces with verbal descriptions. Derived from the ideas of Anderson and Reder (1979), this view has been referred to as the *elaboration* hypothesis.

Each of these three hypotheses has been used to explain improved memory for visual information accompanied by or followed by verbal information. Indeed, they need not be thought of as mutually exclusive. The three experiments to be reported here were motivated initially by a concern with how post-pictorial verbal information influences memory for pictures. In existing studies of picture recognition which have provided additional verbal information, that information always could be verified or contradicted by inspection of the picture. However, in the face recognition literature, the verbal information could not be verified against the picture or its representation. Perhaps this difference can account in part for the dissimilar explanations offered in the two domains. Our main question was this: Can post-pictorial verbal information that is *not* verifiable in the picture nevertheless affect recognition of the picture? For example, if the picture depicted a car near a service station, how would recognition of the picture be affected by finding out subsequently that the car had been stolen the previous day?

The interesting feature of such post-pictorial verbal information is that there is no obvious way to incorporate it directly into the representation of the picture. This is because the additional information is rather abstract, with no clear reference to visual characteristics. Yet the information could still increase the meaningfulness of the picture which, in turn, has been shown to improve recognition in more contrived situations (e.g., with Mooney figures, Wiseman & Neisser, 1974; with Droodle drawings, Bower, Karlin, & Dueck, 1975). Post-pictorial verbal information might be seen as leading to a more thorough processing of the representation of the picture, even when the information is not directly related to the visible details of the picture.

Subjects in our experiments viewed photographs of scenes, objects, people, and so forth, presented either alone, followed by a blank interval, or followed by a sentence. All sentences were constructed to provide abstract information that would not be available merely by inspection of the corresponding picture nor by inference. Thus, the verbal information was intended to supplement the picture rather than to verify or to alter part of the picture. The idea behind the construction of such sentences was to examine the influence that general, nonvisual information would have on recognition of pictures. So that any effect would not be due to biasing initial perception of a picture, the verbal information was always presented after its corresponding picture.

Experiment 1

The first experiment addresses our question in its simplest form: Does post-picture abstract verbal information improve recognition of pictures? This question necessitates comparison of performance in a condition where pictures are followed by sentences to performance in an appropriate baseline condition. There are two obvious possible baselines: a condition without sentences wherein the pictures are presented in a continuous stream, and a condition without sentences wherein blank intervals equal in duration to the sentence presentation time are interpolated. Both control conditions were included in Experiment 1 along with the sentence condition.

Method

Subjects. Ninety undergraduate students at the Scarborough Campus of the University of Toronto were paid to participate.

Materials. The stimulus pictures consisted of one hundred twenty 35-mm color slides selected from a heterogeneous assortment of photographs of rural and urban scenes. Sixty of these slides served as the to-be-remembered pictures; the remaining 60 served as lures on the recognition test. Slides of different categories of subject matter (i.e., people, animals, plants, and objects) were divided evenly between to-be-remembered items and lures. The 60 to-be-remembered slides were randomly divided into three sets of 20 slides each, corresponding to the three conditions of the experiment.

For each stimulus slide, a corresponding sentence was constructed that contained additional nonvisual information about that picture. This sentence might describe where the picture was taken, the occupation of the person depicted, or something of the sort. For example, corresponding to a picture of a busy street corner was the sentence "A serious traffic accident occurred here shortly after this picture was taken."

Procedure. Each subject saw all three blocks of slides such that each block was shown under each viewing condition to 30 subjects. Each block appeared first equally often over subjects. Subjects were tested in small groups of from 1 to 6 people. They were told that they would be shown three sets of pictures that they were to remember, and each of the viewing conditions was described briefly. In the *successive* control condition, each picture was presented for 5 s and was immediately replaced by the next picture. In the *blank* control condition, each picture was presented for 5 s followed by a 5-s blank interval. In the *sentence* condition, each picture was presented for 5 s followed by a 5-s display of its corresponding sentence.

One week later, subjects returned for the yes–no recognition test. They were shown the 60 to-be-remembered pictures and the 60 lures, in a random order. Each of these 120 slides was presented for 8 s during which the subject viewed the slide and decided whether it was *old* or *new*. Subjects also assigned a confidence rating to each of their responses using a 3-point scale.[1]

Results and Discussion

The mean proportions of old slides correctly identified as old (hits) were .76 for the successive control, .78 for the blank control, and .84 for the sentence condition. The proportion of new slides incorrectly identified as old (false alarms) was .10.

A one-way analysis of variance (ANOVA) carried out on individual subject proportions of hits revealed a highly significant effect of conditions, $F(2, 178) = 15.21$, $MS_e = .001$, $p < .001$. Planned comparisons indicated that the sentence condition differed reliably from the two control conditions, $F(1, 178) = 30.12$, $p < .001$, but that the two control conditions were not significantly different, $F(1, 178) = 1.58$, $p > .20$.[2]

Relative to either no additional time or to an amount of time equivalent to that for which the sentence was visible, presentation of a related abstract sentence after a picture improved recognition of that picture. This was true despite the fact that the sentence followed the picture, rather than being available during initial picture processing, and the fact that the information in the sentence did not refer to details of the picture. Thus, post-picture abstract verbal information can improve recognition of the pictures, but what is the processing underlying this improvement?

Experiment 2

Although the results of Experiment 1 are consistent with the hypothesis that provision of abstract descriptive information leads to improved picture recognition, an alternative hypothesis remains to be ruled out. Strictly speaking, Experiment 1 simply demonstrates that the interpolation of sentences between pictures improves recognition of the pictures. But is the information conveyed by the sentences crucial to this effect? To examine this question, it is necessary to include a condition in which sentences are provided that are unrelated to their immediately preceding pictures. Thus, Experiment 2 was designed to replicate the sentence advantage already shown and to determine whether this advantage depends on the relevance of the sentence to the picture.

Method

Subjects. Forty-nine undergraduate students at the Scarborough Campus of the University of Toronto participated as unpaid volunteers.

Materials. Fifty-six to-be-remembered pictures with their corresponding sentences and 42 lures were selected from the materials used in Experiment 1. The 56 to-be-remembered pictures were randomly divided into four sets of 14 slides each.

Procedure. Subjects were instructed that they would be shown a sequence of pictures to remember. They were also told that some pictures would be followed by a sentence that might help them to remember that picture, and that other pictures would be followed by a blank interval.

The slides of three of the four sets—a total of 42 to-be-remembered pictures—were then presented. Conditions were blocked and each condition appeared first equally often over subjects. For the *blank* set, the 6-s picture exposure was followed by a 6-s blank interval. (Only this single control condition was used because the two control conditions did not differ in Experiment 1.) For the *related* sentence condition, the 6-s picture exposure was followed by a 6-s exposure of that picture's corresponding sentence. For the *unrelated* condition, the 6-s picture exposure was followed by a 6-s exposure of an unrelated sentence randomly selected from the fourth, nonpresented set. The experiment was counterbalanced so that each of the four sets of to-be-remembered pictures appeared in each of the three conditions for at least 10 subjects.

As in Experiment 1, subjects were tested with a yes–no picture recognition test 1 week after study. The recognition test comprised the 42 to-be-remembered pictures and the 42 lures, presented in random order. Each slide was presented for 8 s, during which the subject viewed the picture, made an *old–new* decision, and assigned a confidence rating to the decision on a 3-point scale.

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[1] In fact, confidence ratings were collected in both Experiments 1 and 2. Although differences in confidence generally were in the same direction as differences in accuracy (significantly so in Experiment 1), these ratings were less sensitive to the manipulations. For this reason, confidence ratings were not collected in Experiment 3 and will not be discussed further.

[2] Although several studies mentioned earlier have shown that pictures can benefit from rehearsal, the successive control and blank control conditions did not differ here, replicating Shaffer and Shiffrin (1972). Apparently making available rehearsal time does not always produce improved picture recognition. It would be worthwhile to discover the conditions that do result in a benefit from such "blank time" following pictures.

Results and Discussion

The mean proportions of old slides correctly recognized as old (hits) were .79 for the blank control, .83 for the unrelated sentence, and .89 for the related sentence. The mean proportion of new slides incorrectly called old (false alarms) was .13.

A one-way ANOVA conducted on individual subject proportions of hits indicated that the conditions differed significantly, $F(2, 96) = 13.42$, $MS_e = .011$, $p < .001$. Newman–Keuls tests demonstrated that each of the conditions differed significantly from each of the other conditions: related from unrelated, $q(1, 96) = 4.37$, $p < .01$, related from blank control, $q(1, 96) = 8.40$, $p < .01$, and unrelated from blank control, $q(1, 96) = 2.91$, $p < .05$.

The results of Experiment 2 replicated the finding of Experiment 1 that post-picture abstract sentences can improve recognition of pictures. Furthermore, the new results indicate that verbal information related to the picture improves picture recognition more than does verbal information unrelated to the picture. However, even the unrelated sentences aided recognition of the pictures that they followed, compared to no verbal information at all. What role does the amount of relevant abstract verbal information play in the improvement of picture recognition?

Experiment 3

The idea behind Experiment 3 was to manipulate the amount of related information contained in the sentence following the picture. Until now, the evidence indicates only that post-picture sentences help picture recognition, and that they help more if they are related to the picture. What would be the effect of varying the amount of nonvisual information in the sentence on recognition of the picture? For example, if the picture depicted a laboratory filled with equipment, sentences like the following could be constructed: (1) *Low* information—"The equipment seen in this lab has not been used much lately, as it is outdated"; (2) *Medium* information—"That lab equipment was previously used by Engineering students, but is not now as it is outdated"; and (3) *High* information—"That Engineering students' lab equipment is outdated, and will be donated to a local school." Would increasing the amount of information lead to an improvement in recognition of the corresponding picture?

Method

Subjects. Of the 96 subjects who participated in the study session, 94 returned a week later for the test. The data of 1 subject were discarded for filling out the answer sheet incorrectly, leaving the data of 93 subjects for analysis. All were students at the Scarborough Campus of the University of Toronto, most participating for bonus points. Subjects participated in small groups of from 1 to 3.

Materials. The stimulus pictures consisted of one hundred twelve 35-mm slides selected from the same set as Experiment 1, although a different subset of the collection was used. Slides were evenly divided over the six categories of animals, plants, people, objects, urban scenes, and rural scenes in both the to-be-remembered and lure sets.

Corresponding to each picture were three sentences which provided nonvisual, but potentially relevant information about that picture. The sentences were designed to vary in the amount of information provided (from low to high), but without variation in sentence length. This was accomplished by progressively increasing the detail and specificity of the basic, low information sentence. As one example, for a picture of a group of university buildings, the three levels of information were created as follows: (1) *Low*—"This university has an excellent reputation for research and is considered to have a top-ranking student population"; (2) *Medium*—"This university has an excellent reputation for its research in biology and has a top-ranking student population"; and (3) *High*—"This university has top-ranking students and has an excellent reputation for biological research in genetic engineering."

Procedure. In the study session, each subject saw 56 of the slides, selected at random. During the test session, all subjects saw 112 slides: the 56 studied slides and 56 lures. Study and lure sets were counterbalanced across eight groups of subjects. In this way, every slide appeared equally often in each of the four experimental conditions—blank, low, medium, and high—and equally often as a to-be-remembered slide and as a lure.

In the study session, subjects were shown the to-be-remembered pictures for 8 s each using a Kodak Ektagraphic AF-2 projector with an automatic timer. Each picture was followed by an 8-s interval that was either blank or contained one of the three types of sentence. Order of conditions was completely randomized (i.e., conditions were not blocked in this experiment). If a sentence was presented, it was always relevant to its corresponding picture. Subjects were informed that there would be a memory test on the pictures 1 week later, and that the sentences following some of the pictures might help them in remembering the pictures.

In the test session 1 week later, subjects were shown the 112 slides, half studied and half lures, at an 8-s rate in a completely randomized order. They were to indicate while viewing each picture whether or not they had seen it by crossing out a *yes* or *no* on an answer sheet in front of them. No omissions were permitted. Following the test session, subjects were debriefed and thanked for their participation.

Results and Discussion

The mean proportions of old pictures correctly identified as old (hits) were .73 for the blank control, .80 for the low sentence, .79 for the medium sentence, and .78 for the high sentence. The mean proportion of new sentences incorrectly identified as old (false alarms) was .09.

A one-way ANOVA conducted on the individual subject proportions of hits revealed a highly significant effect of condition, $F(3, 276) = 7.09$, $MS_e = .010$, $p < .001$. The planned comparison of the blank condition against the three sentence conditions was highly significant, $F(1, 276) = 21.82$, $p < .001$, but the residual was not, $F < 1$. Thus, the finding that addition of nonvisual information after a picture improves recognition of that picture replicated again. However, the amount of information in the post-picture sentence does not seem to be important, at least for the range used here.

Experiment 3 demonstrates that a sentence adding relevant, nonvisual information to a picture improves recognition of that picture. This is consistent with the results of the two preceding experiments. Apparently, though, this improvement in picture recognition does not vary with the amount of relevant information provided, at least over a reasonable range. Although the sentence must be relevant to have its maximum benefit, as shown by the poorer performance in the irrelevant condition of Experiment 2, that seems to be all that is necessary. The question that remains is how to account for this overall pattern of results.

General Discussion

From these three experiments, it is apparent that post-picture verbal information can improve recognition of pictures. Several features of the experiments make this result novel and interesting. First, the information presented subsequent to the pictures was nonvisual in nature, so that it did not simply re-orient the subject to some particular details in the picture. Nevertheless, the verbal information helped in recognition of the picture. Second, the same pattern of results occurred whether the blank versus sentence manipulation was done in blocks (Experiments 1 and 2) or randomly over trials (Experiment 3). This eliminates the possibility that it is simply the surprise value of the sentence that yields improvement. Third, although the improvement in picture recognition was greater with related sentences than with unrelated sentences, the amount of relevant information in the sentence did not seem to matter. Fourth, and perhaps most important, because the verbal information that aided memory was presented after the picture, it must have affected an already formed representation of the picture, not its initial encoding.

At the outset, we considered three hypotheses regarding how memory for pictures is affected by subsequent verbal information. The integration hypothesis maintains that the verbal information is used to revise the original pictorial representation, thereby replacing it. The semantic code hypothesis claims that a semantic representation of the verbal information is created in addition to the original visual representation of the picture. The elaboration hypothesis holds that presentation of the verbal information results in more extensive processing that enriches the original pictorial representation. What can be said now about the plausibility of these hypotheses?

Although none of these can be rejected categorically on the basis of our data, the integration account seems least satisfactory. It is difficult to imagine what would be integrated from the abstract, post-pictorial sentence into the already formed representation of the picture. How would the pictorial representation change? Of course, such integration is not impossible but, taken together with the criticisms discussed earlier, the integration hypothesis appears strained.

From our perspective, the semantic code and elaboration accounts are actually quite similar. In a way, the semantic code hypothesis represents one member of the class of elaboration explanations, the case where a separate verbal code is formed. Although this particular type of elaboration could be taking place, none of the data require the positing of two codes. For this reason, we prefer an account in which the already encoded pictorial representation is elaborated. This explanation, in terms of differential attention and rehearsal, is not too dissimilar from that offered by Graefe and Watkins (1980).

In this view, the post-picture sentence directs the subject to return attention to the just-presented picture. From the subject's point of view, the sentence is a test of memory. The task is to ascertain whether or not the sentence fits the picture. Making this decision essentially functions as a rehearsal of the picture, thereby elaborating the original encoding of the picture. If the sentence does not fit the picture, this is usually obvious in a quick reflection, requiring little further processing. To determine that the sentence does fit the picture may require more extensive processing, especially because the sentences used here did not permit simple checks for particular visual details. Thus, appropriate sentences would lead to more rehearsal of the picture. Because the information in the sentence was always nonvisual, however, extra information would not have produced more rehearsal or better memory. The picture, not the verbal information, is what is elaborated through rehearsal.

In essence, then, nonvisual verbal information presented subsequent to a picture induces the subject to review the representation of that picture. The sentence acts as a cue to process the picture further, thereby bringing about additional elaboration. This elaboration, or rehearsal, improves memory for the picture, as evidenced by performance on a later recognition test. There is a good deal of evidence from work on scene perception (cf. Biederman, 1981; Biederman, Mezzanotte, & Rabinowitz, 1982) that contextual information is necessarily used in interpreting a complex picture. Our abstract sentences may simply be calling the subject's attention to a particular aspect of context, bringing about additional processing of the picture.

The present finding is reminiscent of those reported by Bower and Karlin (1974) and by Winograd (1981) with respect to face recognition. People recognize faces better after making an abstract, nonvisual judgment about the face (e.g., "Is this person honest?") than after making a specific, feature-oriented judgment (e.g., "Is this person female?" or "Does this person have a long nose?"). We can now say that this improvement in memory for visual information due to subsequent abstract analysis if fairly general. This is something of an exception to the usual emphasis on the value of concreteness in mnemonic techniques (cf. Higbee, 1977). It may be that improvement of memory for pictures depends on different factors than does improvement of memory for verbal material. Certainly, picture memory can be improved by post-pictorial abstract information.

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