The Formation of Verbal Schemas: Mediation and Interference Processes

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Abstract

Four experiments were performed to study the formation of memory schemas for sentences. Sentence frames composed of three concepts were created along with five instances for each sentence frame. During training, varying numbers of instances of each sentence frame were presented to subjects. In the test list which followed, only one instance of each frame was presented, and recall of only this test list was required. The two transfer processes proposed by Thorndyke and Hayes-Roth (1979) were in evidence. Increasing the number of instances of a sentence frame in the training list had two separable effects: (a) It increased the probability that a schema was formed in memory representing the presented sentence frame. This schema acted as a mediating structure to facilitate recall of the schema-related sentence presented later in the test list. (b) It increased the likelihood that details of sentences creating the schema would compete at recall with the schema-related test sentence. This interference process diminished recall of the specific sentence presented in the test list. These two processes, one positive and one negative, combined to determine recall performance. Other factors manipulated in the experiments were the spacing and variability of sentence-frame exemplars on the training list and the temporal interval between the presentation of the training and test lists. A mathematical model is presented which generally fits the pattern of the data collected in Experiments 3 and 4. Other proposals of Thorndyke and Hayes-Roth regarding schema formation are also discussed.
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The Formation of Verbal Schemas: Mediation and Interference Processes

In recent years investigators in the areas of cognitive psychology, artificial intelligence, and social psychology have come to believe that organized knowledge structures in memory play an important role in how people perceive, comprehend, and remember information (Bobrow & Norman, 1975; Graesser & Nakamura, 1982; Minsky, 1975; Ajmelhack & Ortony, 1977; Schank & Abelson, we will refer to 1977; Taylor & Crocker, 1981). These knowledge structures are referred to here as memory schemas. A memory schema can be thought of as a prototype for a class of objects, persons, situations, events, sequences of events, actions, or sequences of actions. It seems that a new schema can be created in memory by the repeated occurrence of experiences that are in some way similar to each other. The invariant characteristics of these experiences are abstracted and stored in memory by mechanisms which are not yet well understood by memory investigators. Memory schemas allow a person to perceive, comprehend, and remember novel experiences which have never been previously encountered. This cognitive processing can occur because schemas are available to structure an experienced event, even though some details of that event may be novel.

Memory schemas play an important role in remembering information. For example, if a passage is presented describing the actions associated with the washing of clothes, subjects reading the passage may neither understand nor remember the
information presented, unless they are informed beforehand what the passage is about. Unless the appropriate knowledge structure is first activated, no referential situation can be called up to interpret the information presented (Bransford & Johnson, 1972). A schema provides an "ideational scaffolding" (Ausubel, 1963; Anderson, Spiro, & Anderson, 1978) to which new information can be associated. When a set of information is interpreted in terms of a particular schema, it "instantiates" (instances) that schema (Anderson, 1978). Furthermore, the person reading or hearing the information can use the activated schema to make inferences. Thus, when a passage is presented based on a restaurant script (Schank & Abelson, 1977), experimental subjects will often assume that the person described as eating in a restaurant looked at a menu, even though this was not mentioned in the passage. By making inferences from the activated schema, default values can be generated for objects, persons, and actions not explicitly described. When asked to indicate to whom the order for a meal was given, subjects may indicate that it was a waiter or waitress, even if this information was not provided in the passage.

Another important characteristic of schema-based remembering is that multiple events, each of which instantiates the same schema, may nevertheless have their idiosyncratic information "tagged" so that the events are to some degree discriminable in memory (Bower, Black, & Turner, 1979; Graesser & Nakamura, 1982; Smith & Graesser, 1981; Thorndyke & Hayes-Roth, 1979). Early formulations of the role of schemas in remembering tended to
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minimize the degree to which this discrimination took place (see Alba & Hasher, 1983, for a review of this literature). Yet the capacity of the memory system to discriminate among stored instances of a schema is an important capability. Further discussion of discrimination among multiple instantiations is given below.

Research on memory schemas has increased dramatically in the last few years (Alba & Hasher, 1983), but there are relatively few studies exploring the formation of memory schemas. In these studies the development of schemas used in categorizing random visual patterns typically has been monitored (Anderson, Kline, & Beasley, 1979, 1980; Franks & Bransford, 1971; Posner & Keele, 1968, 1970; Reed, 1972). In this research subjects were trained to classify a number of visual stimuli into a smaller number of categories. The degree of development of a schema in memory was determined by how well subjects classified stimuli never presented before.

Research using categorization judgments of verbal material in the form of sentences has also been studied (Elio & Anderson, 1981) but less frequently than visual material. Our purpose here is to further investigate the formation of verbal schemas. In the experiments to be presented here, verbal material in the form of sentences was used to investigate the development of memory schemas. Moreover, the degree of schema formation was assessed not by categorization of instances but by the recall of presented instances of the schema (Bower, 1974; Hayes-Roth & Thorndyke, 1979; Thorndyke & Hayes-Roth, 1979).
(1979) reported an important set of experiments of this type. They presented subjects with a series of passages. Some of these passages were related to one another, such as passages about different constellations of stars. Thorndyke and Hayes-Roth found that manipulating the degree of similarity of the content of passages affected two processes involved in recall. First, recall was enhanced through repetition, because as more instances of similar material were presented, a memory schema was formed for this material. This schema acted as a memory structure into which new instances of the schema could be assimilated. Later, retrieval of the schema helped cue recall of from memory enabled the information that recently instantiated it. record-keeper" and "fielder" to be recalled. The schema acted as a mediator for information that fit it. Second, the process of schema formation also interfered with the recall of specific instances of the schema. As additional instances of the same schema were presented, the subjects found it increasingly difficult to discriminate between details the information presented most recently and the information presented earlier in training when the schema was being formed.

Hence, presenting passages of the same kind had two contrary effects on recall, one positive and one negative. The similarity of related information allowed the subjects to abstract from it common concepts and form memory schemas. This provided a schema in memory to mediate later learning. But at the same time this training information interfered with the learning of new specific instances of the schema. The problem of explaining both the positive and negative effects of stimulus similarity on learning
is not a new problem in psychology (Osgood, 1949). To get around this theoretical impasse, Thorndyke and Hayes-Roth assumed that schema development preceded in time the interfering factor of accumulated details. From this assumption they expected that recall of the most recent schema instance would first increase as a function of the number of previous instances in training and then decrease. This decrease was expected to occur because the accumulating collection of details in memory associated with the schema interfered with further learning mediated by the schema. This was the result they obtained.

The goals of the present experiments were to attempt to replicate the results obtained by Thorndyke and Hayes-Roth (1979) and to provide further experimental support for the schema mechanisms they proposed. The materials used were different from those of Thorndyke and Hayes-Roth and were created so that experimental manipulations involving repetition and similarity could be easily performed. Sentence frames were made up by relating three randomly sampled categories of nouns (see Appendix A). To illustrate, one sentence frame was "The public official engaged in a financial transaction involving a commercial business on some planet." Thus, specific instances of the sentence frame above were "The mayor bought a store on Mars", "The senator sold a restaurant on Venus", and "The judge purchased a bank on Mercury". Five sentence exemplars of this kind were created for each sentence frame.

In the experiments, subjects were presented with two lists of sentences; the training list and the test list. Subjects were
forced to process the training sentences in such a manner to ensure their comprehension. But when the test list was presented, subjects tried to memorize these sentences in preparation for a later series of recall tests. Only sentences from the test list were to be recalled. We expected that as the number of sentence exemplars from a sentence frame increased in the training list, the probability of forming a memory schema corresponding to that sentence frame would also increase. Because the memory schema represents an abstraction from the sentence exemplars, it was assumed to be comprised of categories common to the concepts used to create the sentence frame itself. The schema could then become a mediating structure available in memory for facilitating later schema-related learning. Increasing the number of sentence-frame exemplars in the training list should increase the probability that the corresponding test-list sentence is processed in terms of the memory schema.

As proposed by Thorndyke and Hayes-Roth (1979), formation of the memory schema should have a positive, mediating effect on the recall of the schematic sentence presented on the test list. However, the presentation of multiple sentence exemplars in the training list should, in addition, interfere with later learning. Retrieval of the schema at the time of the recall test may produce many confusing details from the sentences presented, can produce inter-list confusions, thus lowering earlier. This confusion will result in poorer recall of the details of the test sentence (a form of proactive interference). In summary, repetitions of a sentence frame on the training list
should result in a positive transfer at the level of concepts, but in a negative transfer of specific instances.

In their research Thorndyke and Hayes-Roth (1979) manipulated two experimental factors. One was the amount of training material provided for each schema; and the second was the time interval between the training material and the test material. In the experiments presented here these two variables as well as manipulations were used. In addition, two other factors were also tested. One was the spacing of schema instances in the training list. Spacing could be varied easily, because each schema instance was represented by a single sentence. We hypothesized that increased spacing of schema instances would make discrimination among memory representations of these two improvement of the specific instance sentences easier and improve recall by reducing interference.

A second, additional factor was the variability of the exemplars. Sometimes only one sentence from a sentence frame was repeatedly presented in the training list; whereas in another condition, four different examples of the sentence frame were used. Our hypothesis was that presentation of only one sentence would inhibit the formation of a memory schema. It seemed that for abstraction and schema formation to occur, a variety of instances of the same conceptual relations must occur. With low variability in the training list it was expected that test-list recall would be less than with high variability. With low variability the schematic structures needed to support recall would not be available.

Experiment 1
Method

Materials. One hundred and eleven categories of five words each were selected. Most of these categories were taken from Battig and Montague (1969), such as articles of furniture, fruits, and types of music. Also, some of the Battig and Montague categories were divided into subcategories, such as precious versus nonprecious metals, individuals versus teams, sports, and song birds versus predatory birds. Other categories not in their norms were used, such as royal personages, brands of automobiles, and types of soil. Ninety of these categories were used to form the 30 sentences in the main list, and 21 categories were used to create filler sentences. The categories are listed in Appendix A.

The ninety categories were randomly grouped into thirty sets of three categories each. Because each category contained five instances, five similar sentences could be made by choosing one instance from each category and then adding verbs and other common-action necessary words. The verbs used in the five sentences were different but similar in meaning. These five sentences defined a common-action sentence frame and its corresponding sentence schema. Two sets of five sentences created for six particular categories are shown in Table 1.

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Insert Table 1 about here.

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The procedure used for creating the sentences in the main list was also used to create the seven sets of filler sentences. Each
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of these sets also contained five sentences. Lists. A training list was made up by sampling 10 sets of 10 sentence frames from six of the frames no sentence was included in the training list; from another six frames three sentences, and from final six frames, four sentences. Each of these four sentences was presented twice in the training list, and each sentence was presented before any were repeated. The number of repetitions of each sentence frame in the training list was either 0, 3, or 8. Thorndyke and Hayes-Roth (1979) also used a range of 0 to 8 repetitions.

The second factor manipulated was the spacing of exemplars in the training list. Each sentence exemplar was separated from the other exemplar sentences from the same frame by 0 or 3 other sentences. For those six sentence frames from which no sentence was presented, two of the frames were arbitrarily designated as representing a spacing of zero, three, or eight intervening sentences. This was done for the statistical design, although the "spacing" of sentence presentations is undefined. The training list contained a total of 90 sentences. Sixty-six of these represented sentence frames upon which the subjects were being trained, and 24 were filler sentences used to fill any gaps remaining in the list caused by the spacing manipulation.

The test list was composed of 28 sentences. The first five sentences and the last five sentences were filler sentences, providing primary and recency buffers. The middle 18 sentences had not been presented in the training list, but 12 of them were new instances of the 12 sentences frames presented in the
training list. In addition, six sentences were included that represented those six frames never shown in the training list. These six sentence frames represented the zero-repetition condition.

A computer program was used to create the lists and print them for each subject. The program was written to select randomly sentence frames for each condition and to select randomly individual sentences from each of the frames chosen. Also, the arrangement of the spacing and repetition conditions was different in each form of the list.

**Procedure.** Subjects were tested individually using a memory drum which presented the sentences one at a time. Twelve different training and test forms were created and two subjects were tested on each form. The sentences from the training list were presented for 10 seconds each, and the subject had to rate each sentence on a 5-point comprehension scale. A rating of 5 indicated that the sentence was very easy to comprehend, and a rating of 1 indicated that the sentence was very difficult. Immediately after the training list was presented, the subject was informed that for the next list, the test list, comprehension ratings would not have to be made. Rather, each sentence had to be carefully studied to prepare for a later recall test. Each sentence in the test list was shown for 10 seconds. Following the presentation of the test list, subjects wrote down in any order as many of the test sentences as they could recall. A second test followed free recall in which each sentence from the test list was presented with only the third noun missing. The
subject had to write in the missing noun. This was the fill-in test.

Results

Scoring procedures. In scoring free recall all the filler sentences were ignored. Also, each test sentence was scored with regard to only the three nouns. The verbs and other types of words were ignored. We also ignored the order of the nouns so that active-to-passive shifts were considered as correct recalls. One potential problem was that subjects might recall entire sentences from the training list rather than from the test list. If this occurred, the measure of recall would not represent how the training list influenced the learning and recall of the test list, but rather would indicate that the subjects could not distinguish between the two lists. To determine the degree to which the training and test lists were confounded in recall, each sentence recalled in the free-recall test was placed into one of four categories. A sentence could be a fragment containing only one or two nouns instead of three, a sentence could contain the three correct nouns from the test list, a sentence could contain three incorrect nouns but from the correct categories, and, finally, a sentence could contain a mixture of correct nouns and incorrect nouns from the correct categories. Table 2 shows the proportion of sentences presented that were recalled in each of these categories.

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Insert Table 2 about here.

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Almost no sentences were recalled that did not fit into one of these four categories. That is, almost no sentences were recalled that represented combinations of two or more sentence frames. The number of sentence fragments recalled was quite small, as was the recall of sentences containing all category intrusions. For most of the sentences the nouns recalled were either all correct or were a mixture of correct nouns and intrusions from the correct categories. This was also true of the cued-recall procedure used in Experiments 2, 3, and 4, as shown in the lower part of Table 2. Hence, it can be concluded that subjects were recalling sentences primarily from the test list, although errors were occurring in these sentences because of intrusions of similar nouns from the training list. Almost all category intrusions were nouns presented in the training list.

In order to use all the data from Table 2, including data from the sentence fragments and from sentences containing a mixture of correct and incorrect nouns, the analyses reported here are based on the proportion of nouns correctly recalled from each experimental condition. Because the proportion of correctly recalled sentences was low, especially in the free-recall condition, the proportion of nouns recalled provided more useable data than did sentence recall. Table 3 shows the frequency of correct nouns, category intrusions, and other

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nouns recalled in the free-recall and cued-recall conditions of
the four experiments. A preponderance of recalled nouns were
correct nouns, but with a significant proportion representing
category intrusions. Few other types of nouns, such as
extracategory intrusions, were recalled.

Measures of recall. In Experiment 1, two measures of recall
were used: free recall followed by a fill-in test in which the
subject had to fill in the noun missing at the end of each test
sentence. As argued by Thorndyke and Hayes-Roth (1979),
successful free recall of a test sentence is dependent on both
retrieval of the schema representing the sentence frame and
successful discrimination among the various nouns associated with
the schema. The fill-in test, however, seemed to be much less
dependent on the previous formation of a schema. The large
number of recall cues presented for each test sentence in the
fill-in task meant that discrimination among potential words
stored in memory was more important than retrieving an intact
schema.

A second aspect of the scoring procedure was that we scored
not only whether the correct nouns were recalled but also whether
the correct noun category was recalled regardless of the
specific correctness of the word. For example, if the test sentence was
"The senator sold a restaurant on Venus," and the subject
recalled Mars for Venus, then this would be scored as recall of
the correct category for the third noun but not the correct word.
These so-called intracategory intrusions were expected to occur
increasingly as the number of sentences representing a sentence
frame increased in the training list. A large number of correct category recalls indicates that a schema for the sentence frame has been created. A large difference between correct recall and confusional category recall means that the subject was unable to discriminate in memory the nouns stored for the training sentences from the stored ones for the test sentence.

Sentence ratings. Table 4 shows the mean comprehension ratings obtained at each repetition of a sentence frame in the training list.

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Insert Table 4 about here.

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The effect of repetitions was significant, $F(7, 151) = 6.04$, $MSE = .110$, $p < .001$. However, this increase occurred only after the fourth sentence was presented, and the training sentences from each frame began to be repeated. A trend analysis on Repetitions 1 to 4, on which the sentence exemplars were different, showed no significant linear trend.

Correct recall. The proportion of nouns correctly recalled and the proportion of nouns recalled from the correct category are shown in Table 5 for each repetition condition.

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Insert Table 5 about here.

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The effects of training repetitions on the proportion of nouns recalled in free recall was marginally significant, $F(2, 46) = 3.11$, $MSE = .033$, $p = .05$, but the linear component of a trend
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Analysis was significant, $F(1, 46) = 6.22$, $MSE = .033$, $p < .025$.

The proportion of nouns correctly recalled in the fill-in test was also affected by the number of repetitions of the sentence frame in the training list, $F(2, 45) = 7.97$, $MSE = .081$, $p < .005$. As can be seen in Table 5, the proportion of correct nouns recalled increased as the number of repetitions increased.

**Category recall.** When the proportion of words recalled from the correct category was used as a measure of free recall, the effect of repetition was significant, $F(2, 46) = 7.87$, $MSE = .063$, $p < .005$. When recall of nouns from the correct category was used as a measure for the fill-in task, recall performance increased as the function of the number of repetitions increased, $F(2, 46) = 10.31$, $MSE = .042$, $p < .001$. In the four analyses of variance performed in Experiment 1, spacing was never a significant factor nor was the Spacing $\times$ Repetition interaction. Therefore, we will present none of the results divided according to the spacing of the repetitions.

**Discussion**

The results of Experiment 1 provided some evidence for the mediation and interference processes proposed by Thorndyke & Hayes-Roth. The notion that recall was facilitated by mediating schematic structures was supported by a number of results. As the number of repetitions of exemplar sentences increased in the training list, the proportion of correct nouns free recalled from the test list also increased. The formation of a schema for a sentence frame during training provided a mediating structure by which the appropriate sentence from the test list could be learned. Each newly formed schema could be retrieved and used to
recall its corresponding test sentence during the free-recall task.

Recall of category intrusions also provided evidence of schema formation. Both in the free-recall task and in the fill-in task, recall of category intrusions increased with repetitions. This meant that subjects knew what category of word to recall even if they could not call the most recent noun. Recall of category intrusions indicates that schema abstraction had taken place in the sense that sets of categories had become part of the schemas corresponding to sentence frames. This occurred even though no category labels were ever presented.

The results of Experiment 1 also provided evidence for the list-discrimination interference process proposed by Thorndyke and Hayes-Roth (1979). Correct responses in the fill-in test declined with repetitions rather than increased as in the free-recall task. This result is not surprising. Recall in the fill-in test was not dependent on a well-formed schema being available in memory, because a strong retrieval cue was provided. On the other hand, the major task of the subject in the fill-in task was to discriminate between the noun presented on the test list and those presented on the training list. However, repetitions of the sentence frame in the training list strengthened many same-category words in memory so that this discrimination could not take place.

Some results of Experiment 1 offer no support for the idea that a memory schema was formed during training. Comprehension ratings for the different exemplars from each sentence frame did not increase as additional exemplars were presented. If schema
Formation were taking place, we would expect each additional sentence instantiating the schema to be more easily comprehended. Corrected: formation.

Second, no U-shaped curve was found relating recall performance to the number of training repetitions. Thorndyke and Hayes-Roth proposed interference effects follow in time the effects of schema formation to produce a U-shape curve.

A surprising result from Experiment 1 was that the spacing of repetitions in the training list had no effect on either comprehension ratings or on any of the measures of recall performance. We expected an effect because spacing of repetitions should make each sentence-frame instance temporally distinct. Perhaps the spacing values of 0 and 3 intervening items were not different enough to affect performance.

**Experiment 2**

The U-shaped curve relating recall performance to number of repetitions (Thorndyke & Hayes-Roth, 1979) was not found in Experiment 1. Experiment 2 represented a second attempt to produce a U-shaped recall curve. Also, visual-imagery ratings were used rather than comprehension ratings to try to detect any increase in ease of processing additional exemplars from the same frame. The number of repetitions of sentence frames in the training list was again 0, 3, or 8. But because spacing of repetitions was found not to be a significant factor in Experiment 1, the variability of repetitions, rather than their spacing, was manipulated in Experiment 2. In Experiment 1 the levels of free recall were not high, so in Experiment 2 a cued-recall test was used rather than a free-recall test. During
testing the first noun from each test sentence was presented to the subject. From this cue the subject had to recall the complete sentence. This test of cued-recall was followed by the fill-in test used in Experiment 1.

Method

The procedure used in Experiment 2 was the same as in Experiment 1 with the exceptions listed below. The training list contained 94 sentences with three filler sentences at the beginning and end of the list. Filler sentences were not needed within the list, because the spacing between exemplars representing the same sentence frame was always zero. The test list was 30 sentences long with three filler sentences at the beginning and at the end of the list. Each of the six experimental conditions was replicated four times within the lists. The sentences in both lists were presented for 8 seconds each. During the training list the subject gave a 5-point imagery rating for each sentence. A rating of 5 indicated that it was very easy to form a visual image of the sentence, and a rating of 1 indicated that it was very difficult to form a visual image. Following presentation of the test list, subjects received the cued-recall test followed by the fill-in test.

Results

Sentence ratings. The effect of training repetitions was significant, $F(7, 161) = 3.13$, $MS_e = .105$, $p < .001$, as was the Repetition $\times$ Variability interaction, $F(7, 161) = 5.00$, $MS_e = .092$, $p < .001$. As can be seen in Table 4, when the exemplar from a sentence frame was always the same in the training list,
the mean imagery ratings increased at a faster rate than when more than one exemplar was used. However, even in the variable-exemplar condition, the imagery ratings increased over the first four sentence exemplars, which were all different sentences. A trend analysis showed the linear component of the curve to be positive and significant, $F(1, 161) = 12.02, MSe = .092, p < .001$.

**Correct recall.** Repetition had no significant effect on the proportion of nouns correctly recalled in the cued-recall test, although the means tended to increase with training repetitions. Analysis of the fill-in test showed that repetition had a significant effect, $F(2, 46) = 4.88, MSe = .047, p < .025$. As was found in Experiment 1 and shown in Table 5, the proportion of nouns correctly recalled decreased as the number of repetitions increased. There was no significant effect of variability on either measure of correct recall.

**Category recall.** Using the proportion of words recalled from the correct category in the cued-recall task, repetition had a positive and significant effect, $F(2, 46) = 7.25, MSe = .058, p < .005$.

Scoring the fill-in test as to whether the nouns recalled were from the correct category showed that repetition, $F(2, 46) = 17.49, MSe = .038, p < .001$, and variability, $F(1, 23) = 9.24, MSe = .054, p < .01$, were significant. Table 5 shows that category recall increased with the number of repetitions. In addition, when only one exemplar was used in the training list, recall of the correct category was .62. But when the exemplars
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Discussion

The results of Experiment 2 were similar to those of Experiment 1. Using a cued-recall procedure rather than a free-recall procedure did not produce the U-shape curve of Thorndyke and Hayes-Roth (1979). Experiment 2, like Experiment 1, however, did produce data that demonstrate the schema-based mediation and transfer processes proposed by Thorndyke and Hayes-Roth. The mean imagery ratings increased with repetition. This effect did not occur with the comprehension ratings of Experiment 1. This was true even though the first four repeated sentences from the same sentence frame in the variable condition had almost no specific words in common. This increase in ratings indicated that information from a currently developing schema could be utilized even as the training sentences were presented.

The interference process was in evidence also. Correct responses in the fill-in task decreased with repetitions in the training list, even though the proportion of correct category recalls increased. The larger number of training sentences produced a greater number of specific interfering nouns.

Variability also affected performance in Experiment 2, but not in the manner we expected, for variability did not improve recall accuracy. However, subjects did find it easier to form a visual image for these sentences repeatedly presented compared to varied sentence-frame instances. With the same sentence repeatedly presented for each frame, the subjects could concentrate on improving their one image rather than having to
change the components of the image.

Also, recall of any word from the correct category was better under variable exemplars. So subjects were more cognizant of the category of word needed in the variable-exemplar condition than in the constant-exemplar condition. Paradoxically, the larger number of category words did not diminish recall of the correct word. It may be that in the variable-exemplar condition memory schemas were better formed than in the constant-exemplar condition. Correct recall may not have been better with variable exemplars because both schema formation and interference occurred more quickly and offset one another.

Experiments 3 and 4

In the two experiments presented so far, the time interval separating the training and test lists was not manipulated. Thorndyke and Hayes-Roth (1979) reported that recall performance on the test list increased when a 24-hour time interval was interposed between the training and testing phases of the experiment. Experiments 3 and 4 were similar to Experiments 1 and 2 except that in Experiment 4 the test list was presented 24 hours after the training list. It was expected that recall performance would be better in Experiment 4 than in Experiment 3. Furthermore, correct recall for the fill-in task was expected to increase with training repetitions rather than decrease. After 24 hours the nouns used in establishing the sentence schema should be temporally well-differentiated from those in the test list. Therefore, proactive interference should be reduced.

Method
The materials used in Experiments 3 and 4 were the same as those used in Experiments 1 and 2. Three different factors determined the composition of the training list. The number of repetitions of each sentence frame was either 0, 3, or 8. The spacing of exemplars from the same sentence frame was either 0 or 3. The third factor was variability of the repetitions. Either they were all the same sentence or were maximally different, as explained in the Method section of Experiment 2. The training list consisted of 70 sentences, 26 of which were filler sentences. The main list was 18 sentences long including three filler sentences at the beginning and end of the list. Each of the 12 experimental conditions was represented by one sentence frame. Twelve different forms of the matched training and test lists were made up, and two subjects were tested on each form. Subjects rated each sentence in the training list for imagery using a 5-point scale. In the test list, subjects simply studied the sentences in anticipation of a later recall test. The sentences in both training and test lists were each presented for 10 seconds. Three different tests of recall were used. Immediately after the presentation of the test list each subject was administered the test of free recall, then cued recall, and then the fill-in test. The subjects were given as much time as needed to complete each test.

Experiment 4 differed from Experiment 3 because after rating the sentences on the training list, each subject was dismissed. The subject returned 24 hours later, was presented the test list for study, and then was tested on the three recall