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ELABORATIVE INTERROGATION EXAMINED AT ENCODING AND RETRIEVAL

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Abstract

Elaborative interrogation is a higher-order questioning strategy that employs "why" questions (e.g., "Why would that fact be true?") in order to encourage students to connect new information to their own richly developed knowledge base. Two experiments examined the role of prior knowledge for the elaborative interrogation strategy (EI) by presenting university students with information about familiar and unfamiliar animals. Both studies manipulated prior knowledge with Experiment 1 focusing on encoding and Experiment 2 focusing on retrieval processes. Experiment 1 demonstrated that semantic cues facilitated memory performance for facts about unfamiliar animals more so than lexical cues or no cues. Experiment 2 demonstrated that EI students organized the material to a greater extent than repetition students although facts about familiar animals were more organized than unfamiliar animals. Overall, both studies support the hypothesis that elaborative interrogation is most effective when the learner has access to a rich, interconnected knowledge base and is encouraged to access that knowledge base at retrieval. The studies also identify methods of facilitating learning when the learner's knowledge base is less developed.

Introduction

Fact learning is a demanding yet common feature within the educational environment. Recently, investigators have examined strategies that are aimed at facilitating learning of factual information (Woloshyn, Willoughby, Wood & Pressley, 1990). One strategy that has been particularly promising is elaborative interrogation. Elaborative interrogation is a higher-order questioning strategy that employs "why" questions (e.g., "Why would that fact be true?") in order to encourage students to connect new information to their own richly developed knowledge base. A series of studies has demonstrated the potency of this strategy for both child and adult populations across a variety of fact learning tasks (Pressley, McDaniel, Turnure, Wood & Ahmad, 1987; Pressley, Symons, McDaniel,

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Snyder & Turnure, 1988; Woloshyn *et al.*, 1990; also see Pressley, Wood, Woloshyn, Martin, King & Menke, 1992 for a review). More recently, researchers have suggested that prior knowledge is the primary mechanism for the successful implementation of the elaborative interrogation strategy (Willoughby, Waller, Wood & MacKinnon, 1993). For example, the amount of prior knowledge available to the learner seems to mediate the size of the learning gains achieved through this strategy. When learners study material that is easily integrated within existing knowledge, they recall more than when they study less easily integrated materials. When there is little or no prior knowledge, no advantage is found for elaborative interrogation over the common default strategy of rote repetition (Garner, 1990; Willoughby, Wood & Khan, 1994). The two studies presented here manipulate the activation of prior knowledge during encoding and retrieval processes and assess the impact of these manipulations for learning while using elaborative interrogation.

Many studies have demonstrated that new information can be made more memorable if learners create meaningful associative links (e.g., Stein, Morris & Bransford, 1987). Presumably, when creating meaningful associations, learners search their available knowledge and use that information to connect novel to-be-learned materials. According to schema theory, all knowledge about concepts is stored within an interrelated network of more general information. The ease of accessing or searching this knowledge is thought to be related to the richness and level of elaboration of the network (Rumelhart, 1980; Yekovich & Walker, 1986). When students are asked to generate answers to questions (such as the "why" questions in elaborative interrogation), it is expected that they activate schemata (i.e., "existing knowledge", Sadoski, Paivio & Goetz, 1991). These schemata, in turn, help to organize new information which facilitates retrieval (Anderson, 1990; Bower, Black & Turner, 1979; Fiske, 1984; Thorndyke & Yekovich, 1980).

When students use elaborative interrogation to learn novel facts from a familiar domain, they recall much more than when they study novel facts from an unfamiliar domain (Willoughby *et al.*, 1993). This holds true even though students are equally able to generate elaborations in response to the why-questions for both types of facts. One possible reason for this outcome could be that students activate inappropriate or interfering schemata when they attempt to generate elaborations for facts from an unfamiliar domain (Roth, 1990). In other words, the absence of an appropriate semantic cue could negatively affect the acquisition process (Bransford & Johnson, 1973). We hypothesized that providing students with a cue that orients them to appropriate conceptual information when studying facts about an unfamiliar domain would facilitate activation of an appropriate schema. Performance for unfamiliar materials would then be expected to parallel familiar materials where semantic context cues are already available. Experiment 1 manipulated the encoding task by providing different kinds of orienting cues.

Alternatively, it could be the case that the facts from the unfamiliar domain are learned, but that the memory task prevents students from demonstrating their learning. The memory task used in Experiment 1 and in most previous studies (see Willoughby *et al.*, 1993) tests the study material in a random order independent of the initial serial presentation and independent of the context in which it was studied. The random testing procedure may detract from performance. Because the facts are presented serially at study, students may spontaneously integrate the information by using the first facts to understand subsequent items. Elaborative interrogation would be expected to facilitate the integration of information because it encourages students to organize and relate new information to existing information in the knowledge base (see Willoughby *et al.*, 1994). Khan and Paivio (1988) demonstrated that presenting schema names early during study prompted students to organize subsequent information in accordance with the schema names. If learning was measured according to the integration of the materials, retrieval scores may be higher for the facts from the unfamiliar domain than those scores reported in existing studies. Experiment 2 manipulates the retrieval task by asking students to organize the information.

Experiment 1

This experiment contrasts learning for familiar and unfamiliar material (i.e., novel facts about familiar and unfamiliar animals) when learners are primed with different kinds of context cues. Some students were pretrained with semantic context cues which identified the type of animal (e.g., "pig-like animal" for Collared Peccary). Other students were provided with pretraining of just the animal names. It could be argued that learners in previous studies failed to remember facts about unfamiliar animals because they were not familiar with the names or labels associated with those animals. This suggests that lexical knowledge could play a role in the effectiveness of elaborative interrogation. When presented with unfamiliar animals, for example, learners are not only required to learn the new fact but they must also learn the animal label. Hence, learning facts about unfamiliar animals may be more demanding because there are greater demands at encoding. This could result in two problems: the student could be diverted from learning the fact while trying to determine a referent for the label; or the student could fail to acknowledge the label while focusing on the fact. Therefore, we included a condition where students were primed for exposure to vocabulary.

On the other hand, if knowledge base is the most important predictor for memory performance, the typical decreased performance found with the unfamiliar material could be a function of students failing to access an appropriate knowledge base. To test this, some students were provided with semantic context cues at study. It was assumed that pretraining with semantic context cues would allow learners access to an appropriate knowledge base especially for unfamiliar materials. In summary, we examined the relative benefits of providing semantic context, lexical, and no pretraining cues with both familiar and unfamiliar materials. We hypothesized that pretraining would not affect memory for familiar animals because students in all conditions would have ready access to a knowledge base. With unfamiliar animals, however, only the presentation of semantic context cues would provide students with access to an appropriate knowledge base and therefore their performance for the unfamiliar animals should exceed the lexical or no cue conditions.

Method

Subjects and Design

Forty-eight undergraduate students (24 females and 24 males) who were enrolled in an introductory psychology course participated in this experiment. Students ranged in age from 17 to 44 years of age (mean age = 21 years, 8 months, SD = 5 years, 2 months). Students were randomly assigned to one of three elaborative interrogation conditions: context; lexical; and control.

Materials

One set of 10 animal stories was constructed. Five stories were about familiar animals (e.g., Swift Fox) and five described unfamiliar animals (e.g., Collared Peccary). Each story was composed of six simple declarative statements which outlined six characteristic behaviors for each animal, for example, physical living environment, diet, major source of predation, etc. (facts from Willoughby *et al.*, 1993 and Wood, Pressley, & Winne, 1990; see Appendix for an example of a familiar and unfamiliar story set). To ensure that the familiar and unfamiliar animals selected for this study would indeed correspond to undergraduate students' knowledge, Willoughby *et al.* (1993) pretested an equivalent population for their familiarity with the animals and the facts. Following this pretesting, familiar and unfamiliar animals were identified.

All stories were typed on 12 × 19 cm white cards. One sentence was typed on each card. An orienting direction describing the subject's task was typed (in upper case) below each statement: "WHY WOULD THAT ANIMAL DO/HAVE THAT?" Three cards in each set served as examples that were used when instructions were provided for the subjects. The 60 remaining sentences were the study materials.

Procedure

The experimental session included pretraining, instructions and practice, presentation of the study materials, and memory test.

Pretraining. Pretraining in the lexical condition involved familiarizing the students with the animal names. Students were first provided with a list of the 10 animal names. The experimenter read the list and asked the subjects to repeat the names to ensure appropriate pronunciation. Students then completed a series of exercises which required them to generate some aspect of the animal name. For example, students completed fill-in-the-blank exercises which varied in difficulty from recalling the animal type (e.g., Swift________, answer "fox") to the complete name (S________F________). The experimenter also required students to generate aloud the animal names when provided with the initials. Students were asked to discriminate across the animal labels with exercises such as "Can you remember the three animals that start with the letter c?" Students were encouraged to rehearse the list if they made errors on any of the exercises. Students were provided with exercises until they achieved 100% accuracy.

In the context pretraining condition, subjects were presented with the animal names and a brief description of the animal (e.g., Collared Peccary is a pig). The experimenter read the list of names plus descriptions and asked the subject to read it back. Similar to the lexical condition, subjects were given a series of exercises (fill in the blank, etc., C________P________=P________) until they memorized the animal name and type together. When students successfully completed all exercises and could generate the animal name and type from memory they proceeded to the study task. In the no cue condition, students proceeded directly to instructions and practice.

Instructions and practice. Participants were told that they would be shown individual sentences stating true facts about animals and that they would be asked to remember that information. Students were instructed to read each sentence and answer out loud the "why" question written below each statement, such that the answer clearly stated why the fact was true of the specific animal being discussed and not another similar animal. Three example sentences were presented to the students with feedback provided about their performance. For example, students were prompted to further elaborate their answer or generate another elaboration if their answer did not explain the relation between the animal and its habit.

Students were then given a practice memory test for the three practice items. Students were provided with the animal behavior in the form of a which-question (e.g., "Which animal eats clams and other shelled sea creatures?") and were required to select the appropriate animal name (i.e., walrus) from a list of the three practice animals. Students were also provided with feedback about their performance on this test.

Study phase. Students were reminded of their instructions and the 10 stories were presented with no feedback provided. Each sentence was presented for 15 seconds, with a 15 second interval separating the presentation of each of the 10 sentence sets. Sentences were presented in a constant order across subjects.

Memory test. After all 60 sentences were presented, students were given a two-minute filler task (multiplication problems). Each student was then asked to complete a matching test. The experimenter presented each fact to the subject in the form of a question; for example, "Which animal especially likes to live in open areas?" The subject was then asked to select the appropriate animal from a page which contained the animal names. The test questions were presented in a different random order for each student.

Results and Discussion

The main analysis involved a repeated measure analysis of variance (ANOVA) with pretraining condition (semantic, lexical, and no cue) as the between subjects variable and familiarity as the within subjects variable (3×2 design). The memory performance data are summarized in Table 1.

There was a significant main effect for familiarity, $F(1, 45) = 158.22$, $p < .001$, with better performance for familiar animals ($M = 20.77$) than unfamiliar animals

Table 1
Mean Correct Familiar and Unfamiliar Animal Matching Scores as a Function of Pretraining in Experiment 1

		Familiar	Unfamiliar
Control	Mean	20.31	11.38
	SD	(4.53)	(3.36)
Lexical	Mean	21.38	12.25
	SD	(2.63)	(5.13)
Context	Mean	20.63	16.88
	SD	(3.28)	(4.41)

Note. Maximum score = 30 per cell.

(M = 13.50), and no significant main effect for pretraining, $F(2, 45) = 2.96, p > .05$. Most critically, the anticipated interaction between pretraining and familiarity was obtained, $F(2, 45) = 9.28, p < .001$. Follow up Dunn–Bonferroni comparisons (critical $t(45) = 2.76$; Kirk, 1982) were conducted. When students examined facts about familiar animals, performance was equal across all three pretraining conditions (context = lexical = control), largest $t = -.76$ for control versus lexical. However, when the elaborative interrogation students studied unfamiliar material, there was a clear advantage for the context group relative to both the lexical and control groups, smallest $t = 3.28$ for context versus lexical comparison. The lexical and control groups did not differ, $t = .62$.

In summary, the differences among pretraining conditions were only evident for the familiar animals. Providing students with context cues prior to study facilitates learning for unfamiliar animals to a greater extent than lexical or no cue conditions. Clearly, lexical information was not sufficient to enhance performance. Although students may fail to retrieve animal labels when provided with the behavior, this retrieval failure does not appear to be a function of inappropriate processing of the animal label. However, providing students with a context cue which encourages them to activate appropriate background knowledge enhances performance for the facts about the unfamiliar animals.

Experiment 2

In previous studies, memory performance was generally assessed by asking students to remember each of the animal facts independently and in a random order (e.g., Woloshyn *et al.*, 1990; Willoughby *et al.*, 1993; and Experiment 1 reported here). This task does not reflect the study demands where students were exposed to a series of connected facts. Students most probably organized the six related animal facts when they studied. Experiment 2 examined the organization that students employed to learn the facts by manipulating the retrieval task. It was hypothesized that retrieval would reflect the encoding process. We expect that when using elaborative interrogation, students would find it easier to organize and integrate familiar rather than unfamiliar materials because they have a rich knowledge base with which to form interconnections. So although students would attempt to organize both types of materials, we would still expect to find an advantage for familiar versus unfamiliar items. To assess the level of organization, we manipulated the retrieval task by asking students to organize the animal facts into stories without using the animal label.

We also included a second verbal strategy (repetition) to allow for comparison with previous research and to assess organizational differences promoted by the two strategies. Typically, elaborative interrogation is compared to repetition because this strategy serves as a default strategy for most students (Garner, 1990). Because repetition encourages serial processing of the information, it would be expected that repetition students would organize the facts (Zember & Naus, 1985), but not to the extent that would be encouraged by the meaningful processing involved in elaborative interrogation. Typically, memory performance in the elaborative interrogation condition does not exceed performance in the repetition condition for unfamiliar materials. Our task removes the associative component of matching each fact to its appropriate animal label and instead requires students to recognize related pieces of information and organize them into sets. Elaborative interrogation should facilitate the integration and organization of facts more so than repetition even for the unfamiliar materials because repetition does not encourage integration of the facts. In summary, we expect greater organization in the elaborative interrogation than the repetition condition for both familiar and unfamiliar materials.

Method

Subjects and Design

Thirty two undergraduate students (16 females and 16 males) who were enrolled in an introductory psychology course participated in this experiment. Students ranged in age from 17 to 39 years of age (mean age = 20 years, S.D. = 4 years, 6 months). Students were randomly assigned to one of two conditions: elaborative interrogation or repetition control.

Materials and Procedure

Two sets of 60 animal facts were prepared. One set was identical to that used for the elaborative interrogation condition in Experiment 1. The set used for the repetition condition paralleled the one used in the elaborative interrogation condition but had the study prompt "READ AT A RATE THAT ALLOWS YOU TO UNDERSTAND THAT THE FACT IS TRUE" typed below each fact. The repetition students were asked to repeat each sentence aloud at a rate that allowed them to learn the facts as presented and understand that each fact was true of the particular animals being discussed. As in Experiment 1, all students practiced their strategies with three practice items prior to studying the 60 animal facts. Unlike Experiment 1, after studying the animal facts students were presented with the list of 60 animal activities presented in random order (without the animal name). Students were told to organize these activities into intact stories (i.e., facts that they thought went together). No restrictions were made on the number of facts that could be organized together or on how often each fact could be used (most students did not exceed stories of six units, nor did they use the facts more than once). After organizing all of the facts, students were provided with a list of the animal names and were asked to match each set of organized facts to the appropriate animal name.

Results and Discussion

At test, students were asked to perform two tasks. The first task was to organize the information without reference to the animal labels followed by the second task where students matched the animal names to the facts. Analysis of students' organization was measured by the degree to which they clustered the information. The repetition ratio (RR) (Begg, 1978; Murphy, 1979) was used as an analysis of the extent to which students had listed facts about the same animal together as a unit (see Table 2 for RR formula).

Table 2
Memory Organization as a Function of Condition and Familiarity as Measured by the Repetition Ratio Score in Experiment 2

Condition		Familiar	Unfamiliar
Elaborative Interrogation	Mean	.6550	.4600
	SD	(.205)	(.264)
Repetition	Mean	.4600	.2950
	SD	(.208)	(.215)

Note. $RR = r/n\text{-}1$ where r equals category repetitions occurring in a recall list of n items.

The RR measure ranges from a score of 0 for chance clustering to a score of 1 for maximum possible clustering. Means are summarized in Table 2.

A repeated measures analysis of variance (ANOVA) was conducted on the organization scores with study condition (elaborative interrogation and repetition) as the between subjects variable and familiarity as the within subjects variable (a 2 × 2 design). There was a main effect for study condition, $F(1, 30) = 6.33$, $p < .05$, with elaborative interrogation ($M = .558$) outperforming repetition ($M = .378$). There was also a main effect for familiarity, $F(1, 30) = 27.55$, $p < .001$, with familiar animals ($M = .558$) being better organized than unfamiliar animals ($M = .378$). The interaction was not significant, $F < 1$.

These data support the hypothesis that when using elaborative interrogation, the knowledge base needs to be well-developed in order for greater schematic organization to occur. When the knowledge base is restricted, it is much more difficult to access and integrate appropriate schemata. In this experiment, for example, even when the extra demand imposed by learning an unfamiliar animal name was removed, facts about unfamiliar animals were still more difficult to organize. Even though elaborative interrogation demonstrated better organization with the familiar animals, there was still an advantage over repetition when unfamiliar animals were examined. This finding is contrary to the conclusions drawn from matching test data where elaborative interrogation was deemed to be equivalent to rote repetition.

The second task replicated previous studies where students matched the newly organized facts with the appropriate animal name. Memory performance was determined by adding the number of correct matches (animal name with fact) from the list of animal facts that the students placed beside each animal name. Means are presented in Table 3.

A repeated measures analysis of variance (ANOVA) was conducted on the matching test scores with study condition (elaborative interrogation and repetition) as the between subjects variable and familiarity as the within subjects variable (a 2 × 2 design). There was a main effect for study condition, $F(1, 30) = 4.59$, $p < .05$, with elaborative interrogation ($M = 30.88$) outperforming repetition ($M = 20.69$). There was also a main effect for familiarity, $F(1, 30) = 44.90, p < .001$, with higher matching scores for familiar items ($M = 16.66$) than unfamiliar items ($M = 9.13$). The interaction was not significant, $F(1, 30) = 2.01, p > .05$. To parallel comparisons conducted with past research, however, Dunn–Bonferroni simple effect comparisons were conducted (critical $t(30) = 2.36$; Kirk,

Table 3
Mean Correct Familiar and Unfamiliar Animal Matching Scores as a Function of Condition in Experiment 2

Condition		Familiar	Unfamiliar
Elaborative Interrogation	Mean	20.00	10.88
	SD	(6.52)	(7.79)
Repetition	Mean	13.31	7.38
	SD	(7.89)	(7.48)

Note. Maximum score = 30 per cell. n = 16 per condition.

1982). Consistent with all previous research (Willoughby *et al.*, 1993, Willoughby *et al.*, 1994), performance in the elaborative interrogation condition was significantly greater than in the repetition control for the familiar animal facts, $t = 2.54$. In addition, memory performance in the elaborative interrogation condition did not differ from the repetition control condition when the materials were unfamiliar, $t = 1.33$. This replication of the typical performance pattern suggests that examining only the matching test data may underestimate the quality of study that elaborative interrogation supports.

General Discussion

Together, these two studies identify the importance of activating appropriate schemata in order to maximize learning when using elaborative interrogation. Elaborative interrogation was most beneficial when students studied material that allowed them to access existing knowledge. This most probably reflects the construction of interconnections between the to-be-learned materials and existing knowledge during study and ease of access to the material on retrieval. A unique finding here is that elaborative interrogation still permits some important active processing of information even when the knowledge base is less developed. Even when the learner's knowledge base is limited, using elaborative interrogation appears to encourage some expansion of existing networks.

One feature of these two studies is that they suggest means by which students' performance can be mediated when materials are less familiar. To date, researchers investigating elaborative interrogation have noted that student performance in less familiar domains is much lower, and as a result these researchers have cautioned practitioners that elaborative interrogation may not be an appropriate strategy for such materials. The first experiment, however, indicates that encoding can be enhanced even for unfamiliar domains by providing students with appropriate semantic cues prior to study. Appropriate cues orient the learner to relevant knowledge. Experiment 2 suggests that practitioners should evaluate the critical features of the task in order to support retrieval. For example, if the task is to encourage deeper processing and integration of the material, then an appropriate measure of the effectiveness of the strategy is to employ a test of organization rather than a recognition or recall test. If the task is an associative one, however, then elaborative interrogation may not be the most effective strategy. Alternate strategies, such as imagery and mnemonic techniques, may be more beneficial for this type of learning (Willoughby *et al.*, 1994).

In academic tasks, there is a high demand for students to learn factual information. As students progress through the educational system, the onus for learning this material is increasingly placed upon the learner. In order to succeed, learners must be able to generate and employ effective strategies on their own. Before students employ strategies independently, however, they first must have an opportunity to acquire the strategy. Elaborative interrogation is a strategy that not only can be explicitly taught within the classroom (Wood, Fler & Willoughby, 1992), but it is also a strategy that can be independently employed by students.

In summary, these two experiments support the hypothesis that elaborative interrogation is most effective when the learner has access to a rich, interconnected knowledge base and is encouraged to access that knowledge base at retrieval. However, to maximize performance when using elaborative interrogation, educators need to develop an instructional context that is sensitive to the learner and is consistent with the encoding and retrieval demands of the task at hand.

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Appendix

Example of a Familiar and Unfamiliar Animal Story Set

Western Spotted Skunk (Familiar Animal)

1. The Western Spotted Skunk's hole is usually found on a sandy piece of farmland near crops.
2. The Western Spotted Skunk mostly eats corn.
3. The biggest danger to the Western Spotted Skunk is the great horned owl.
4. The Western Spotted Skunk lives in a hole in the ground.
5. Often the Western Spotted Skunk lives alone, but families of skunks sometimes stay together.
6. The Western Spotted Skunk is able to live close to people but never be seen.

Collared Peccary (Unfamiliar Animal)

1. The Collared Peccary lives in southwestern United States.
2. The Collared Peccary eats roots and cactus.
3. The biggest dangers for the Collared Peccary are the jaguar and mountain lion.
4. The Collared Peccary often rests in a thicket or under a large boulder.
5. There are no apparent leaders among the Collared Peccary males and females.
6. The Collared Peccary's stomach has two compartments.