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The Effect of Prior Knowledge on an Immediate and Delayed Associative Learning Task Following Elaborative Interrogation

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Prior knowledge as a mediator of the effectiveness of the elaborative interrogation strategy was evaluated in this study. University students were given facts about animals and instructed either to answer "why" each fact would be true of the particularly animal being discussed (elaborative interrogation) or to read each fact aloud at a rate so that they could understand it (repetition control). Half of the animals were familiar to the students and the other half were unfamiliar. The elaborative interrogation group outperformed the repetition control group on an associative memory test for the familiar animals only, both on an immediate post-test and on a 1-month-delayed post-test. To facilitate memory of facts, the elaborative interrogation strategy requires general knowledge related to the to-be-learned content. © 1993 Academic Press, Inc.

Many students face the challenge of developing effective ways to learn and remember factual information. Elaborative interrogation is one strategy that facilitates such learning (Pressley, Symons, McDaniel, Snyder, & Turnure, 1988; Woloshyn, Willoughby, Wood, & Pressley, 1990). In elaborative interrogation, learners are asked to answer "why" questions about information that they read, such as: "Why would that fact be

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true?" A variety of explanations have been offered for the elaborative interrogation effect, such as arousal, cognitive effort (Hasher & Zacks, 1979; Tyler, Hertel, McCallum, & Ellis, 1979), or generation effect (Slamecka & Graf, 1978; Slamecka & Fevreiski, 1983). In other words, elaborative interrogation may be effective because students put great effort into answering the "why" questions or because they *self-generate* answers. However, the favored hypothesis (Martin & Pressley, 1991; Woloshyn, Pressley, & Schneider, 1992) is that it encourages use of relevant prior knowledge that the learner does not activate unless prompted to do so.

One powerful piece of evidence in favor of the prior knowledge interpretation is that only "why" questions that stimulate activation of relevant prior knowledge succeed in boosting learning (Martin & Pressley, 1991). Moreover, a study by Woloshyn *et al.* (1992) demonstrated facilitation due to elaborative interrogation when students studied facts pertaining to their own countries but much more modest facilitation when they studied facts pertaining to another country. Although consistent with the knowledge activation hypothesis, confidence in the interpretation would have been stronger if there had been *no* facilitation when learning content from the less familiar domain. The criticality of such a knowledge by strategy interaction as support for the knowledge activation explanation of elaborative interrogation effects stimulated the investigation reported here, one in which the familiarity of the material was stringently manipulated.

Animal facts were presented to adult students for study. Half of the facts pertained to particular varieties of common species and half to exotic species. If the prior knowledge activation explanation of elaborative interrogation effects is correct, facilitation should occur only with the common species.

Students in a pilot test of this study often used the first few facts given about an animal at study to help them answer subsequent "why" questions about the animal. Thus, we suspected that although participants might begin the study with no prior knowledge related to the exotic animals, they might have enough knowledge by presentation of the third, fourth, fifth, or sixth fact to come up with an adequate elaboration. To evaluate this possibility, students were randomly assigned to one of two groups: one which received the facts separated according to animal and another which received the facts according to topic [10 facts about sleep (1 for each animal) and then 10 facts about source of predation, etc]. We reasoned that the topical organization would not allow students easy access to information presented previously about an animal and, thus, assure that in this condition, responses to "why" questions would be based on prior knowledge.

METHOD

Subjects and Design

One hundred undergraduate students (50 females and 50 males) enrolled in an introductory psychology course participated in this study. Students ranged in age from 18 to 36 years of age (mean age = 19 years 5 months, SD = 2 years). Forty students were randomly assigned to each of the elaborative interrogation and repetition control groups. Half of the students in each condition were presented the facts according to animal and half according to topic. Twenty additional students were randomly assigned to the no-exposure control condition; these students were presented the criterion test questions without prior exposure to the facts. Their performance provided information about students' prior knowledge for the facts.

Materials

Four sets of stimulus materials were constructed, each consisting of 10 stories, with two sets for the elaborative interrogation condition and two sets for the repetition control condition (within each condition, one set for topic condition and one set for animal condition). Each of the 10 stories was composed of six simple declarative statements describing the animals' special attributes. Each statement described one characteristic, for example, physical living environment, diet, major source of predation, natural habitat, social relationships, and special adaptations. (See the Appendix for a sample of each format.)

To ensure that the common and exotic animals selected for this study would indeed correspond to undergraduate students' knowledge, 40 different students were asked to indicate their familiarity with a number of animals. The following 10 animals were chosen because the students indicated unanimously that they were either familiar with the animals (selected for common species) or unfamiliar with the animals (selected for exotic species). The 5 animals representing common or familiar species included the *Western Spotted Skunk, Swift Fox, Little Brown Bat, House Mouse,* and *Townsend Mole.* The 5 representatives of exotic or unfamiliar animals were the *Pronghorn, Chickaree, Collared Peccary, Coati,* and *American Pika.* All stories were typed on white 12 × 19-cm cards, one sentence to a card. For the elaborative interrogation condition, an orienting direction describing the subjects task was typed (in upper case) below each statement: "WHY WOULD THAT ANIMAL DO/HAVE THAT?"

Three additional cards for each condition served as practice examples that were used when instructions were provided (e.g., *Bears like to live near the water*). The remaining sentences were the critical to-be-learned information.

Procedure

The experimental session consisted of two phases. Phase I included instructions plus practice, presentation of the to-be-learned materials (study phase), and a post-test on the facts studied during Phase I. Phase II consisted of a delayed post-test 1 month after study.

Phase I—Instructions and practice. Participants were told that they would be shown 60 true facts about 10 different animals. The students in the conditions that were presented the facts organized according to animal were also told that several sentences concerning the same animal would be presented one after the other, and that the experimenter would tell them when a different animal was about to be introduced. Subjects in the topic conditions were told that the animal facts would be separated according to topic. All sentences were presented for 15 s.

The specific instructions that were given to the participants varied as a function of their condition. Participants in the elaborative interrogation condition were instructed to read each sentence and answer out loud the "why" question written below each statement. It was emphasized that their answer should state why the fact was true of the specific animal being discussed. The students were told that the purpose of the experiment was to investigate whether answering questions about sentences helps people to learn information, and that they would be tested for memory of the facts that were presented at the end of the session. They were instructed to respond to the "why" question after each fact was presented.

Repetition control students were asked to read each sentence out loud at a rate that would allow them to learn the facts as presented and understand that the fact was true of the specific animal being discussed. They were told that the purpose of the experiment was to investigate the rate at which people read sentences in order to learn information contained in the sentences, and that they would be tested for memory of those facts at the end of the session. These subjects were instructed to continue reading the sentence aloud for the entire time it was presented (such a control guaranteed that the repetition subjects remained on-task and processed facts meaningfully for the entire time they were presented).

Students were then presented with the three example sentences. Feedback on their performance with the sample items was provided. For example, students in the elaborative interrogation condition were prompted to elaborate their answer additionally or generate another elaboration if their answer did not explain the relation between the animal and its habit. Similarly, repetition control students were prompted to read the sentences clearly for the full time that they were presented.

Phase I—Study phase. Following the instructions, the 10 stories were presented with no feedback provided. A 15-s interval separated the presentation of each animal set. Within the animal-organization and topic-organization conditions, sentences were presented in a constant order across subjects. The order was determined randomly such that no more than two familiar or unfamiliar animals were presented in a sequence.

Phase I—Memory test. After all 60 sentences were presented, students in the fact-presentation conditions were given a 2-min filler task (multiplication problems). Each student who had been presented the facts was then given a memory test: students were asked to match the facts to the appropriate animal. The experimenter presented each fact to the subject orally in the form of a question; for example, "Which animal especially likes to live in open areas?" The subject then selected the appropriate animal from a typed list. The 60 test questions were presented in a different random order for each student.

Phase II. Four weeks after Phase I, all fact-presentation students completed the matching test again.

RESULTS

No-Exposure Control Analysis

To determine whether memory performance in the fact-presentation conditions could have been a function of existing knowledge about the animals, the no-exposure control group completed the matching test without being exposed to the study materials (See Table 1 for means). Chance performance on this test was 3 out of 30 for each fact type (i.e., familiar or unfamiliar animals), since there was a 1 in 10 chance of matching each one of the facts to its correct animal. Matching was significantly above this chance value for the familiar animals, $t(19) = 9.80, p < .001$; for unfa-

TABLE 1
MEAN CORRECT FAMILIAR AND UNFAMILIAR MATCHING SCORES AS A FUNCTION OF CONDITION AND TEST

Condition	Phase I		Follow-up	
	Mean	*SD*	Mean	*SD*
	Familiar animals			
Elaborative interrogation	19.85	4.47	13.03	3.95
Repetition control	15.60	3.20	10.43	3.49
No-exposure control	6.50	2.12		
	Unfamiliar animals			
Elaborative interrogation	11.13	4.21	6.85	2.81
Repetition control	11.18	3.94	7.05	2.91
No-exposure control	3.15	1.60		

Note. Maximum score = 30 for each task. n = 40 for elaborative interrogation and repetition conditions. n = 20 for the no-exposure control condition.

miliar animals, no-exposure control performance was at chance, $t(19) = 0.32$, $p > .05$. When the content comes from a familiar domain, students seem better able to narrow down the alternatives before making a guess.

Because of unequal sample sizes and unequal variances, planned comparisons between the matching scores of the no-exposure control group as compared to the Phase I scores of the elaborative interrogation and repetition control groups were analyzed using the Welch–Aspin test (Marascuilo & Serlin, 1988; Maxwell & Delaney, 1990). Both the elaborative interrogation and repetition control conditions significantly outperformed the no-exposure control, smaller $t(57) = 15.07$, $p < .01$ for the repetition versus no-exposure control comparison. Therefore, scores in conditions exposed to the animal facts reflected more than just prior experience. In addition, with matching scores separated as a function of familiar and unfamiliar animals, performance in the elaborative interrogation and repetition control conditions was significantly greater than in the no-exposure control group, smallest $t(55) = 10.56$, $p < .01$ for the unfamiliar animal scores of the elaborative interrogation group versus the no-exposure control group. It is interesting to note the repetition control group's strong learning gains in Phase I as compared to the no-exposure control group. While repetition may not be a sophisticated strategy, it clearly can benefit the learner.

Primary Matching Analysis

The main analysis involved a repeated measures analysis of variance. The between-subjects variables were condition (elaborative interrogation and repetition control) and format (animal or topic presentation), while

the within-subjects variables were familiarity of the animal and time of test (2 × 2 × 2 × 2 design). All follow-up comparisons were analyzed using Tukey's HSD procedure unless otherwise stated. There was a main effect for condition, $F(1,76) = 8.15$, $p < .006$ ($M = 25.43$ for elaborative interrogation and $M = 22.13$ for the repetition control); format, $F(1,76) = 5.55$, $p < .02$ ($M = 25.14$ for topic presentation and $M = 22.42$ for animal presentation); test, $F(1,76) = 332.11$, $p < .001$ ($M = 28.88$ at post-test and $M = 18.68$ at follow-up); and familiarity, $F(1,76) = 190.50$, $p < .001$ ($M = 29.46$ for familiar animals and $M = 18.11$ for unfamiliar animals).

Each of the above effects, however, was qualified by a significant interaction. Most critically, the anticipated interaction between condition and familiarity was obtained, $F(1,76) = 18.64$, $p < .001$ (See Table 1 for means). The elaborative interrogation group performed significantly better than the repetition control group for the *familiar animals only*, $t(76) = 3.72$, $p < .05$ for the familiar animals and $t(76) = -.13$, $p > .05$ for the unfamiliar animals.

There was also a significant test by familiarity interaction, $F(1,76) = 13.02$, $p < .001$. The difference between post-test and follow-up scores for familiar animals ($M_{diff} = 6.00$) was greater than that for unfamiliar animals ($M_{diff} = 4.21$). In addition, the main analysis revealed a format by test interaction, $F(1,76) = 6.04$, $p < .016$. Groups that studied the animal facts separated according to topic had a matching score loss from post-test to follow-up ($M = 30.93$ at post-test to $M = 19.35$ at follow-up) greater than that of the groups that studied the animal facts separated according to animal ($M = 26.83$ to $M = 18.00$). It may be that the topic groups noted the similar structure of the stories (habitat, diet, predators, etc.) to a greater extent at study than the groups with the animal format and were able to use that structure to help them distinguish between the animals at immediate testing, $t(76) = 4.51$, $p < .01$ (topic versus animal comparison at post-test). There was no difference as a function of presentation format on the delayed test, $t(76) = 1.49$, $p > .05$.

Relation between Quality of Answers to the "Why" Questions and Memory Performance

For the elaborative interrogation groups, subject responses to the "why" questions were scored as adequate, inadequate, or no response. Adequate responses made clear why the stated fact was true of the particular animal. All other responses were classified as inadequate (e.g., when the response was just a repetition of the fact, was incomplete, or stated that "the animal just *likes* to do that"). Twenty-five percent of the responses to the "why" questions were scored by two raters to determine interrater reliability. There was 94% agreement in classification of re-

sponses, and disagreements were resolved by discussion. The remaining responses were scored by one rater. The response qualities are summarized in Table 2.

The adequate elaborations were further subdivided into correct, incorrect, and pat responses. Correct elaborations were responses that corresponded with expert knowledge of the animal. Pat responses were elaborations that were too general (for example, the Western Spotted Skunk eats corn because that food is available in the area that it lives). Again, 25% of the responses were scored by two raters with 95% agreement (disagreements resolved by discussion). The remaining responses were scored by one rater. These classifications are also summarized in Table 2.

The mean number of adequate–correct elaborations was significantly greater with the familiar animals than with the unfamiliar animals, $t(78) = 5.66$, $p < .01$. However, the reverse was true for the adequate–pat and adequate–incorrect categories, where the mean number of elaborations with the unfamiliar animals was significantly greater than with the familiar

TABLE 2
MEANS AS A FUNCTION OF ADEQUACY OF ANSWERS TO "WHY" QUESTIONS IN THE ELABORATIVE INTERROGATION CONDITION

Category	Mean	*SD*	%
Total animals			
Inadequate	14.30	7.54	23.9
No response	3.80	4.75	6.3
Total adequate	41.90	8.90	69.8
Correct–adequate	31.40	8.30	
Incorrect–adequate	6.38	3.37	
Pat–adequate	4.13	3.25	
Familiar animals			
Inadequate	6.28	3.74	20.9
No response	1.28	1.84	4.3
Total adequate	22.45	4.22	74.8
Correct–adequate	18.73	5.08	
Incorrect–adequate	2.43	1.85	
Pat–adequate	1.30	1.74	
Unfamiliar animals			
Inadequate	8.03	4.42	26.8
No response	2.53	3.25	8.4
Total adequate	19.45	5.41	64.8
Correct–adequate	12.68	4.46	
Incorrect–adequate	3.95	2.36	
Pat–adequate	2.83	1.96	

Note. Maximum score = 60 for total animals and 30 for familiar and unfamiliar animals.

animals, smaller $t(78) = 3.20$, $p < .05$ for the adequate–incorrect category. In short, better responses were provided for the familiar than for the unfamiliar animals.

A series of item-by-item conditional probabilities was calculated to determine the relation between the quality of answers provided at study and subsequent memory performance. Each elaboration provided at study was matched to the corresponding response at recall. Because not every subject provided responses for all categories and there were heterogeneous variances, the Games–Howell procedure (Kirk, 1982; Howell, 1987; overall $p < .05$ for each set of comparisons) for unequal sample sizes and unequal variances was used to assess differences between categories; the significant differences are summarized in Table 3. In general, while correct elaborations were important, too general of an elaboration

TABLE 3
MEAN CONDITIONAL PROBABILITIES OF TOTAL, FAMILIAR, OR UNFAMILIAR CORRECT MATCHING SCORES AS A FUNCTION OF ADEQUACY OF ANSWERS TO THE "WHY" QUESTIONS IN THE ELABORATIVE INTERROGATION CONDITION

		Phase I		Follow-up	
Category	*n*	Mean	*SD*	Mean	*SD*
Total animals					
Inadequate	40	.467[a]	.168	.275[a]	.146
No response	29	.392[a]	.360	.258[a]	.327
Total adequate	40	.550[a]	.133	.363[a]	.093
Correct–adequate	40	.598[a]	.136	.381[a]	.114
Incorrect–adequate	40	.425[b]	.256	.269[b]	.249
Pat–adequate	36	.322[b]	.304	.256[b]	.248
Familiar animals					
Inadequate	40	.691[a]	.227	.391[a]	.281
No response	19	.484[a]	.418	.302[a]	.418
Total adequate	40	.676[a]	.160	.461[a]	.130
Correct–adequate	40	.703[a]	.172	.465[a]	.154
Incorrect–adequate	36	.547[a,b]	.387	.339[a]	.359
Pat–adequate	22	.462[b]	.438	.458[a]	.392
Unfamiliar animals					
Inadequate	40	.311[a]	.222	.205[a]	.176
No response	28	.350[a]	.387	.252[a]	.368
Total adequate	40	.408[a]	.164	.243[a]	.120
Correct–adequate	40	.449[a]	.183	.252[a]	.141
Incorrect–adequate	38	.358[a,b]	.266	.216[a]	.280
Pat–adequate	35	.269[b]	.309	.220[a]	.263

Note. Means within columns within each division line that share superscripts do not differ significantly; $p < .05$ per comparison set.

was not beneficial (adequate–pat). Descriptively, the probability of correct recall was always greater for the adequate–correct elaborations than for the other categories across both familiarity and test. Consistent with previous research (see Pressley, Wood, Woloshyn, Martin, King, & Menke, 1992), there were no differences between the adequate, inadequate, and no-response categories. Most likely, students were in the process of formulating a response but just ran out of time.

The effect of format (topic or animal presentation) on the number of adequate elaborations was also evaluated since subjects in the topic condition did not have as easy access to previous facts presented about an animal, thereby making it more difficult to use those previous facts to come up with an adequate elaboration. The result might have been less adequate elaborations in the topic condition. That did not occur, however, regardless of whether total, correct, incorrect, or pat categories were considered. There were also no differences in the inadequate and no-response categories as a function of presentation format. In summary, the topic versus animal format manipulation did not affect the quality of the elaborations.

DISCUSSION

The hypothesis that the elaborative interrogation group would have significantly greater matching scores than the repetition control group for the familiar animals *only* was supported. This was despite the fact that students were able to come up with elaborations most of the time for the unfamiliar animals. Answering "why" questions affected learning of facts only when learners possessed extensive prior knowledge.

The interaction between prior knowledge and strategy instruction offers strong support for the knowledge base interpretation of elaborative interrogation's potency because the competing explanations of arousal, cognitive effort, or generation effect would have predicted an advantage for elaborative interrogation regardless of familiarity with the material. If anything, arousal and effort might have been expected to be higher with low prior knowledge, where the students would have had to work much harder to generate elaborations. It is not active learning per se that is responsible for elaborative interrogation benefits, but the making of connections to prior knowledge. Therefore, this study suggests that mechanisms such as arousal, cognitive effort, and the generation effect cannot stand on their own as explanations for why the elaborative interrogation strategy benefits fact learning.

The durability of the elaborative interrogation effect was measured by having students complete the matching test *1 month* after study of the facts. That the positive effect for the elaborative interrogation group

versus the repetition control group was still present suggests the robustness of the effect and bolsters the position that it may be educationally useful.

The scoring system used here, unlike more general scoring systems used in previous research (Pressley *et al.*, 1988; Woloshyn *et al.*, 1990, 1992), revealed how critical the quality of an elaboration can be. It was important for learners to have correct elaborations. Producing elaborations that were too general (i.e., adequate–pat elaborations) did not help the students to *distinguish* among the animals at testing. When the animals were unfamiliar, students resorted more often to pat responses and guesses, undoubtably because learners lacked the prior knowledge to provide more complete answers.

Investigations of the interaction between prior knowledge and strategy instruction are important from a pragmatic perspective as well. Elaborative interrogation is a strategy that should be recommended for learning content from familiar domains. No significant benefits resulted from using elaborative interrogation when prior knowledge was low. Even more sanguine reports of the efficacy of elaborative interrogation when prior knowledge is low (i.e., Woloshyn *et al.*, 1992) suggest small, probably inconsistent effects of elaborative interrogation in the absence of prior knowledge. This contrasts with large, consistent effects of elaborative interrogation when prior knowledge is high, in this report and all previous research (Pressley *et al.*, 1992).

APPENDIX

Example of Topic Format: Social Relationships

The Swift Fox usually lives by itself. The Pronghorn's offspring usually are twins, but they always sleep separately. If House Mouse populations grow too dense, females become infertile. The Little Brown Bat rarely mates in winter. The Chickaree is highly territorial. The Townsend Mole is aggressive and quarrelsome. There are no apparent leaders among the Collared Peccary males and females. The Coati male is completely subordinate to the female. Often the Western Spotted Skunk lives alone, but families of skunks sometimes stay together. The American Pika constantly communicates with its fellows.

Example of Animal Format: Western Spotted Skunk

The Western Spotted Skunk's hole is usually found on a sandy piece of farmland near crops. The Western Spotted Skunk mostly eats corn. The biggest danger to the Western Spotted Skunk is the great horned owl. The Western Spotted Skunk lives in a hole in the ground. Often the Western Spotted Skunk lives alone, but families of skunks sometimes stay to-

gether. The Western Spotted Skunk is able to live close to people but never be seen.

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