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# Elaboration strategies and individual differences in academic achievement among adolescent learners

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# Elaboration Strategies and Individual Differences in Academic Achievement Among Adolescent Learners

By

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## Abstract

This study investigated the relative potency of four memory strategies for learning factual information. To examine the efficacy of the strategies in relation to academic ability, students were classified as low or average achievers based on their performance on a verbal skills measure. Tenth to twelfth grade students (62 females and 48 males) were randomly assigned to one of four experimental conditions: Elaborative Interrogation (EI, a "why" questioning strategy), Repetition of Provided Elaborations (PE), Repetition Control (RC), and Judgement/Analysis (J/A, where students evaluated provided elaborations and justified their judgement). Performance in the EI condition was greater than that in the RC condition for the average achievers. There were no differences across conditions within the low achievement group. Within the EI condition, average achievers performed better than low achievers-- an expected finding since low achievers have less relevant knowledge to access when generating elaborations. Neither achievement group benefitted from provision of elaborations (PE) even when the task entailed extensive processing as in the J/A condition.

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## Introduction

The goal of educators is not only to impart knowledge to their students but to provide students with strategies that they can employ independently to facilitate the acquisition of knowledge. Recently, a series of articles have advocated an associative learning strategy called elaborative interrogation (Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987; Pressley, Symons, McDaniel, Snyder, & Turnure, 1988; Woloshyn, Willoughby, Wood, & Pressley, 1990; Wood, Pressley, Turnure, & Walton, 1987; Wood, Pressley, & Winne, 1990). Elaborative interrogation is a learning strategy thought to enhance storage and retrieval of information. In elaborative interrogation, learners are instructed to answer a "why" question when presented with to-be-learned information (i.e., "Why would this fact be true?"). This sort of questioning is thought to enhance memory by prompting the learner to relate new information to previous knowledge, thereby making the information more meaningful. Although prior knowledge appears to be the primary facilitating component, the elaborative interrogation strategy also enhances memory performance because it allows the learner to organize information more effectively (Woloshyn, Willoughby, Wood, & Pressley, 1990). It also activates the associative connections within learners' semantic repertoires (Willoughby & Wood, 1992).

Willoughby, Waller, Wood, and MacKinnon (in press) demonstrated that elaborative interrogation is dependent on knowledge base by manipulating the familiarity of the to-be-learned information. It is reasonable to presume that individuals would lack a knowledge base for unfamiliar information. Results indicated that compared to rehearsal, elaborative interrogation facilitated memory only for familiar topics. No differences between elaborative interrogation and rehearsal were found when the topics were unfamiliar indicating that the efficacy of the elaborative interrogation strategy was dependent upon forming associations in memory between to-be-learned information and previous knowledge. This study also demonstrated that the generation effect (i.e., better recall of self-generated elaborations; Slamecka & Fevreiski, 1983; Slamecka & Graf, 1978) could not account for the success of the elaborative interrogation strategy. Although subjects generated elaborations for unfamiliar as well as familiar animals, only recall for the facts about familiar animals was facilitated by elaborative interrogation indicating that possession of a knowledge base for the domain of interest facilitated recall. The other competing hypothesis for the success of the elaborative interrogation strategy is cognitive effort (i.e., conscious processing of information; Jacoby, 1978; Tyler, Hertel, McCallum, & Ellis, 1979). The

study just described discounts this explanation because subjects who generated elaborations for unfamiliar animals expended just as much, if not more, effort than those who generated elaborations for familiar animals, yet subjects who studied facts about familiar animals had higher recall scores.

In adult populations, learning gains from using the elaborative interrogation strategy have been shown to exceed one standard deviation relative to the default rehearsal strategy or rehearsal of experimenter provided elaborations (Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987; Pressley, Symons, McDaniel, Snyder, & Turnure, 1988). The potency of the elaborative interrogation strategy has also been demonstrated in younger populations. For example, Wood, Pressley, and Winne (1990) found that fourth- to eighth-graders in the elaborative interrogation condition outperformed those in both the reading control group and those who studied information that was elaborated to explain the relation among the elements of the fact (i.e, precisely elaborated information).

Some developmental trends in the effectiveness of the elaborative interrogation strategy also seem to be apparent. For example, Wood, Pressley, and Winne (1990) found that the older children more closely approximated the performance of adults than the young children. It was hypothesized that

older children are able to use the elaborative interrogation strategy more effectively since they have more expansive knowledge bases and hence, they are better able to make meaningful connections between new information and existing knowledge. The pattern observed by Wood, Pressley, and Winne could be elucidated even further if it was known how the elaborative interrogation strategy impacts on learning in adolescents. In this study, the sample population was comprised of adolescent students so that developmental implications for the elaborative interrogation strategy could be proposed.

The quality of elaborations generated in response to the "why" question in elaborative interrogation has also been shown to impact on learning. For example, precise elaborations, compared to imprecise ones, are more memorable (see Stein, 1978; Stein & Bransford, 1979). Stein and colleagues provide the following examples of precise and imprecise elaborations: "The tall man purchased the crackers that were on sale." and "The tall man purchased the crackers that were on the top shelf." In the former example, the underlined phrase is an imprecise elaboration of the base sentence because it fails to explain the significance of a tall man purchasing the crackers, although it is semantically congruous with the base sentence. In the latter example, the underlined phrase specifies the

significance of a tall man purchasing the crackers and hence is a precise elaboration since the arbitrariness between the conceptual elements of the sentence is reduced making the information more meaningful.

In adult populations (i.e., university undergraduates) the quality of generated elaborations does not impact on learning when to-be-learned information is about a topic domain for which some prior knowledge can be presumed to exist (see Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987; Woloshyn, Willoughby, Wood, & Pressley, 1990). It might seem that, for adults, the mere attempt to generate an elaboration involves such thorough processing that learning is enhanced. Consistent with the depth of processing theory of memory (Craik & Lockhart, 1972), if learners have a developed knowledge base, they would have a rich semantic network from which to draw information. Students have to engage in a thorough search in order to access the appropriate semantic network. This would be considered deep processing rather than the more peripheral processing that might be invoked with repetition.

Younger students (i.e., 4th- to 8th-graders) recall more information when they generate adequate (i.e., precise) elaborations rather than inadequate (i.e., imprecise) ones. However, for these younger learners, generating an elaboration, regardless of the adequacy of the response,

does not facilitate learning any more than failing to generate a response when attempting to answer the "why" question in elaborative interrogation (see Wood, Pressley, & Winne, 1990). It seems then, that for younger learners, the mere activity of searching for information is not sufficient to enhance memory performance. Instead, they seem to require specific and appropriate information. This is substantiated in subsequent analyses where more information is recalled following generation of adequate elaborations that contain factually correct information than adequate elaborations that contain factually incorrect information. Incorrect elaborations interfere with recall of information. This leads us to believe that the efficacy of elaborative interrogation is dependent on knowledge base because the elaborative interrogation strategy forces learners to relate new information to their prior knowledge. It is the quality of the association formed between to-be-learned information and prior knowledge that accounts for the facilitative effects of elaborative interrogation on memory.

Elaborative interrogation is a sophisticated learning strategy because it requires considerable prerequisites before it can be utilized successfully. In general, such associative strategies are not often spontaneously employed by learners (Pressley, Wood, & Woloshyn, 1990). Many learners may lack the skills necessary to execute these

strategies even when explicitly instructed to do so. For this reason, the present study also examined learners across varying levels of achievement. Due to the highly verbal nature of the elaborative interrogation task, verbal abilities were assessed in order to determine whether such skills impacted on recall or predicted the quality of generated elaborations. It might be expected that younger (novice) learners and less successful students may not benefit from instruction in elaborative interrogation relative to older or more academically successful peers.

There is evidence that individuals who differ in academic ability utilize qualitatively different strategies to learn information, with academically successful students tending to take a more active and strategic role in learning (Bransford, Stein, Vye, Franks, Auble, Mezynski, & Perfetto, 1982; Rohwer, Rabinowitz, & Dronkers, 1982) and less successful students employing less sophisticated strategies such as re-reading new information rather than relating it to their prior knowledge (Garner, 1990a; 1990b). Wong and Sawatsky (1985) found that gifted readers spontaneously used advanced learning strategies, such as self-questioning and activating prior knowledge, while average and poor readers had to be trained to use such strategies. Wong & Sawatsky provided further evidence that academic ability predicts retention in fifth- to seventh-graders. They found that

students with good reading skills (i) provided more precisely elaborated continuations to base sentences and (ii) performed better on incidental recall tests than students with average and poor reading skills. Stein, Bransford, Franks, Owings, Vye, and McGraw (1982) also found that academically successful fifth-grade students were more likely to provide precise endings to base sentences compared to their less successful counterparts who were more likely to provide imprecise elaborations to base sentences.

There is also evidence that academically successful students accommodate their studying to meet the demands of the task. For example, Franks, Vye, Auble, Mezynski, Perfetto, Bransford, Stein, and Littlefield (1982) found that academically successful students allotted study time more effectively than less successful students. Specifically, more successful students realized that implicit textual information required more processing and spontaneously allotted more time to studying it than to studying explicit information. Finally, there is evidence that individuals with low academic ability may approach and learn information like novices who have limited knowledge bases (Bransford, Stein, Vye, et al., 1982). In comparison to low achievers, academically successful students may have a more extensive knowledge base with which to make elaborative associations. Low achievers may be less

proficient at generating elaborations and may require the aid of experimenter provided elaborations. In this study, memory performance was assessed across levels of academic achievement so that the differential impact of the strategies on learners of different abilities could be examined.

In addition to investigating developmental trends and individual differences in strategy use, the relative efficacy of other strategies was investigated. For example, elaborative interrogation (EI) was compared to repetition (RC), a popular default strategy used by learners to study new information (Garner, 1990a; 1990b). Another condition entailed repetition of information containing experimenter provided elaborations (PE). The provided elaborations parallel the typical presentation of information in expository text. After presentation of factual content, text materials are expanded upon through elaborations to clarify the relation within the fact. The PE condition in this study provided an ecologically valid comparison to expository text. The PE condition also provided an opportunity to determine whether the provision of elaborated information supported the learning of less skilled learners who presumably possess low levels of prior knowledge which would result in them being unable to make connections between new information and existing knowledge. Finally, a

condition was included that required students to judge the adequacy of provided elaborations and explain/analyze their judgements (judgement/analysis, J/A). Such a strategy entails active processing of new information, yet poses few demands on the learner to activate prior knowledge.

In previous studies where students were asked to study information that contained experimenter provided elaborations, there was no variation in the quality of provided elaborations-- they were always precise, therefore prohibiting any evaluation of the impact of quality of elaboration on subsequent recall. In this study, the impact of the provided elaborations relative to generating an elaboration and the impact of quality of provided elaborations on subsequent recall were examined. Therefore, students in the provided elaboration conditions of this study were asked to study both precisely and imprecisely elaborated sentences. It was predicted that low achievers would recall precisely elaborated information more frequently than imprecisely elaborated information because precise elaborations reduce the arbitrariness of information (Bransford, Stein, Vye, et al., 1982) hence, making it more meaningful. It was also predicted that the low achievers would benefit from the provision of experimenter provided elaborations because they have less extensive knowledge bases with which to connect new information. The average

achievers who, presumably, have more extensive knowledge bases than the low achievers were expected to perform well in the elaborative interrogation condition and were not expected to require the support of provided elaborations to facilitate their recall of factual information.

Since the activity of repeating elaborated information is not comparable in cognitive effort (Jacoby, 1978; Tyler, Hertel, McCallum, & Ellis, 1979) to generating elaborations in the elaborative interrogation condition, the judgement/analysis (J/A) condition was also included. In the judgement/analysis condition, students were asked to judge the quality of provided information and explain their judgement. In this way, the demands on the students' knowledge base were reduced compared to the elaborative interrogation condition, yet they were active learners since they were forced to focus on the elaboration and on how well the elaboration explained the base sentence. This also permitted some assessment of the students perception of the provided elaborations. To date, all studies have assessed precision using expert ratings. Experts are individuals who are trained to recognize when an elaboration clearly defines a precise relation. It could be argued that expert ratings may not accurately reflect the unique knowledge base or spontaneous association of individual learners. Alternatively, it might be expected that some learners,

especially novices or low achievers may be less able to discriminate between good and poor elaborations (consistent with Bransford, Stein, Vye, et al., 1982). This could be examined through the impact of students judgements of elaborations on recall. Therefore, the judgement/analysis condition also served to determine the compatibility between expert and novice knowledge bases.

In summary, the following study attempts to address several major issues: developmental trends in strategy use, individual differences in achievement as predictors of successful implementation of strategies, the role of precision as a function of achievement level and strategy use, and the relative efficacy of memory strategies. The developmental trends follow from Wood, Winne, and Pressley (1990) who found developmental differences in the use of the elaborative interrogation strategy between the older and younger children in their sample of fourth- to eighth-graders such that older children recalled more than their younger peers. Given that the older children approximated, but did not match, the performance typically found in the adult studies, this study extended the developmental perspective by including an adolescent population which has, to date, not been tested with these elaboration strategies.

The impact of academic achievement on the use of elaboration strategies is another issue that is of interest

in this study. Observations of fifth graders suggest that academically successful students tend to take a more active role in learning (Bransford, Stein, Vye, et al., 1982; Franks, Vye, Auble, et al., 1982; Rohwer, Rabinowitz, & Dronkers, 1982). Conversely, less successful students tend to employ more basic strategies such as re-reading material, and usually do not use their prior knowledge to full advantage (Garner, 1990a; 1990b). Less successful students often require explicit training in sophisticated strategies in order to enhance their learning (Swing & Peterson, 1988; Wong & Sawatsky, 1985). It was expected that students varying in levels of academic achievement would benefit differentially from elaboration strategies. In comparison to low achievers, average achievers have a richer, more extensively developed knowledge base with which to make associations. Providing these successful students with a strategy that activates their knowledge base (elaborative interrogation) maximizes their potential for learning by encouraging them to use their available resources. Less successful students may be less able to generate elaborations because of their more limited knowledge base and may require the support of experimenter provided elaborations to maximize learning. This issue is addressed by comparing the effectiveness of strategies in students of differing achievement levels.

## Method

### Subjects

One hundred and ten 10th- to 12th-grade students (48 male and 62 female) attending one of two high schools in Southern Ontario volunteered to participate in this study on intentional learning. Permission to conduct the study within the school setting was obtained from two Canadian school boards (Separate and Public School Boards). Informed consent was obtained from students prior to their participation in any of the study procedures. All students were asked to read a letter of information about the study and were encouraged to show it to their parents. Students under 16 years of age were required to have their parents sign the consent form for their participation in the study.

The sample was comprised of 15 10th-graders, 31 11th-graders, and 64 12th-graders. Students ranged in age from 15 to 19 years ($M$ = 16 years, 6 months, SD = 1 year). Students were randomly assigned to one of four experimental conditions: Repetition (RC), Experimenter Provided Elaborations (PE), Judgement/Analysis (J/A), and Elaborative Interrogation (EI).

Although there is evidence that females might outperform males in all of the conditions in this study due to their higher verbal skills, the data in this study were not analyzed by gender. The concern was to determine the

efficacy of the strategy in a heterogenous sample of students. In order to control for the impact of gender on the results of this study, males and females were distributed in approximately equal proportions across the conditions so that there would be equal representation of males and females in the conditions.

## Materials and Procedure

### Screening for Academic Achievement

In the first phase of participation, students completed The Metropolitan Achievement Test (MAT6-- Form L, Prescott, Balow, Hogan, & Farr, 1986) in their own classroom. Detailed instructions, as well as examples, for completing the MAT6 were provided. The MAT6 was used to assess verbal proficiency in vocabulary, reading comprehension, spelling, and language skills. Scores on the MAT6 could range from zero to 147.

Vocabulary test items consisted of 24 sentences containing a blank and four choices for "filling in the blank" were provided for each sentence. Students were asked to choose the word that best fit the sentence. Students were allowed 15 minutes to complete the vocabulary subtest. In order to do well on this subtest, students would need a good understanding of semantics and syntax. Spelling test items also consisted of incomplete sentences (25 items). Students were provided with four spellings of a single word

and were asked to select the correct spelling of the word that would complete the sentence (students were allowed 10 minutes to complete this subtest). In the reading comprehension test (50 items), students were asked to read eight passages and answer six or seven multiple-choice questions for each passage (students were allowed 30 minutes to complete this subtest). Finally, the vocabulary subtest was comprised of 48 incomplete sentences and students were asked to "fill in the blank" with the answer that completed the sentence properly (4 choices were provided). Students were allowed 35 minutes to complete the language subtest. To do well on this subtest, students must (i) have a good understanding of punctuation and capitalization rules, (ii) be able to determine the standard form of irregular verbs, (iii) know that double negatives are incorrect, and (iv) ensure that the subject and predicate of sentences are in agreement.

Students were grouped into one of two achievement categories, low or average, based on normative percentile scores on the Metropolitan Achievement Test. Thirty-one students comprised the low academic achievement group whose scores fell below the 30th percentile based on norms for their grade level. Seventy-nine students comprised the average achievement level group whose scores fell between the 30th and 70th percentile based on norms for their grade

level. Although students were screened for high achievement, only nine students met the criteria of scoring over the 70th percentile, and they were not included in the analyses given the small sample. An ANOVA indicated a significant main effect for raw achievement scores between the two achievement levels, $F(1,108) = 169.18$, $p < .001$. The random allocation of subjects to strategy conditions within each achievement level resulted in a 2(achievement level) X 4(condition) factorial design.

Experimental Session

Subjects returned individually for a second session in which they were asked to study animal facts using one of the four learning strategies: Repetition (RC), Experimenter Provided Elaboration (PE), Judgement/Analysis (J/A), or Elaborative Interrogation (EI). Four sets of 54 declarative sentences about familiar animals were constructed for presentation to students in all conditions. All facts were pretested for content and structure in both fourth- to eighth-graders (see Wood, Pressley, & Winne, 1990) and adults (see Willoughby, Waller, Wood, & MacKinnon, 1990). These materials provided information that was novel, yet drew from a topic domain for which learners had some general knowledge. The sentences contained information about nine animals (grey seal, townsend mole, emperor penguin, little brown bat, blue whale, house mouse, swift fox, western

spotted skunk, and american pika). Six sentences depicted the environment, diet, sleep habit, predators, preferred and global habitat of each of nine animals (see Appendix A for an example). The factual content of the sentences was verified by experts (zoologists and game wardens) or textual sources (e.g., journals, encyclopedias, and biology texts).

The sentences were each typed on white cards (12cm X 19cm) in capital letters and underlined. In the elaborative interrogation condition, an orienting direction describing the subjects' task was typed below each base statement (e.g., "WHY WOULD THAT ANIMAL DO/HAVE THAT?). In the provided elaboration conditions, each sentence contained a non-underlined explanatory elaboration that specified why the animal had the specified attribute. In the repetition condition, the declarative statement was presented on its own. A practice item from each of the study conditions would be:

| | |
|---|---|
| Elaborative Interrogation | BEARS LIKE TO LIVE NEAR THE WATER.<br>WHY DOES THAT ANIMAL DO THAT? |
| Provided Elaboration Conditions | BEARS LIKE TO LIVE NEAR THE WATER SO THAT THEY CAN CATCH FISH TO EAT AND SWIM TO COOL OFF IN THE HOT WEATHER. |
| Repetition | BEARS LIKE TO LIVE NEAR THE WATER. |

One set of these base sentences was used for the repetition condition. The second set contained the same base sentences with a "why" question typed below it and was used in the elaborative interrogation condition. The two remaining sets

of cards were used in the provided elaboration conditions (PE & J/A). In the provided elaboration conditions, an imprecise and a precise elaboration were constructed for each fact. Half of the imprecise facts for each animal were assigned to one set and the remaining half to the other set. Likewise, half the precise items were assigned to each set. Therefore, the two sets of animal facts were mirror opposites of each other so that the presentation of precise and imprecise elaborations was counterbalanced in the provided elaboration conditions (see Appendix A).

The sentences were prerecorded on audiotape (female voice) at 18 second intervals between each sentence. A pause followed each sentence to provide time for the learner to "study" the information as instructed. A "beep" indicated the presentation of the next sentence. Two tape recorders were used. One was used for playing the prerecorded sentences and the other was used to record responses (i.e., repetitions, judgements/analyses, or elaborations of information) generated by the learners. A colour picture (20cm X 25cm) depicting each animal was presented along with the relevant sentences in each experimental condition. A five-item filler task and a 54-item cued recall test were also used (see Appendix B for recall test items).

Procedure

Prior to the experimental session, students were tested in groups for verbal proficiency. Students returned individually for the experimental session which began with training for use of a memory strategy and practising the strategy. The "study" portion of the session followed, [illegible] students were asked to use the strategy that they received instruction in to learn 54 animal facts. Students were then asked to complete a five-item filler task before responding to the cued recall test items.

Before the trials in the experimental session began, three sample sentences were provided to students in each condition. Students in the repetition (RC) and experimenter provided elaboration (PE) condition practised repeating the sentences aloud at a rate that would enable them to comprehend the sentence so that they could recall the information later. In these conditions, emphasis was placed on comprehension and students were asked to repeat and understand the facts. Students in the PE condition were told that focusing on the provided elaboration while repeating the sentence would help them remember the information.

In the J/A condition, students were presented with an elaborated sentence like "Bears like to live near the water where they can catch fish to eat and swim to cool off in the

hot weather.". They were told that a good elaboration of the base sentence would explain why only that animal in particular rather than any other animal would engage in that activity. Learners were asked to focus on the provided elaboration and (i) judge whether it was a good or poor explanation of the fact, and (ii) give a rationale for their judgement. The practice session lasted until the experimenter was sure that the student understood the task and was able to make reasonable judgements and analyses for the sample sentences. No time constraints were imposed and responses were not recorded for the practice trials.

Students in the EI condition generated responses to the "why" question (Why does that animal do that?) when presented with a fact like: "Bears like to live near the water.". They were provided with detailed instructions on how to use the EI strategy and were told that asking "why" questions like "Why would that fact be true of that animal?" helps people remember information. The experimenter also specified that good answers to "why" questions explain why a given fact is true of that animal in particular and no other animal. Students were asked to generate answers to the "why" question until the experimenter was satisfied that they could generate an adequate elaboration. There were no time constraints imposed for these practice trials and the experimenter provided feedback and prompting until an

adequate elaboration was generated. Responses for the sample trials were not recorded.

Students in all four conditions then completed a sample recall test for the three practice items. For example: "Which animal likes to live near the water?" (Answer: bear).

After the practice session, students were presented with the 54 to-be-learned animal facts. Each set of animal facts was presented on individual cards so that subjects could read the sentence while listening to the prerecorded sentences. A picture of the animal was presented along with the facts. After each animal, a prerecorded 18 second pause allowed time for the picture of the next animal to be introduced so that subjects could examine it before the facts for that animal were presented.

After the "study" portion of the experiment, students completed a five-item filler task and then responded to a 54-item cued recall test (see Appendix B for recall test). Recall test items were asked in a mixed random order. The filler task was comprised of items that students believed were assessing their prior knowledge about animals. For example, "Are you interested in animals?" and "Do you watch T.V. documentaries about animals?". These items were used to ensure that recall of the facts presented about the last animal would not be artificially inflated due to recency effects.

## Results

### Recall

The primary focus in this study was on the results pertaining to the recall data with subsequent interest in the quality of provided and generated elaborations as well as students perceptions of quality. Recall data were analyzed using Dunn-Bonferroni planned comparisons'. Two sets of six comparisons were calculated, one set for the less proficient students and another for the average academic achievers. Each set of comparisons was conducted at $p \leq .05$, cutoff $t(102) = 2.69$.

The mean recall scores for each achievement group within the experimental conditions are reported in Table One. Within the average achievement group, students in the

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Insert Table 1 About Here

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elaborative interrogation condition outperformed those in the repetition control condition, $t = 3.33$, $p \leq .05$. The other comparisons within the average achievement group were not significant, largest $t = 2.38$ for the comparison between the elaborative interrogation and repetition of provided elaboration conditions. All comparisons within the low achievement group were non-significant, although there was a trend for elaborative interrogation to outperform repetition

control ($t$ = 2.21, $p$ > .05).

Comparisons between achievement levels within each condition were also performed. The assignment of subjects to conditions was balanced so that each condition was comprised of approximately equal numbers of low achievement students. Similarly, the average achievers were distributed approximately equally across conditions. However, the number of low achievers was considerably smaller than the sample size of average achievers. To compensate for the discrepant sample sizes between the average and low achievement groups, Tukey-Kramer's Modification of the HSD procedure was used (Kirk, 1982). Comparisons were conducted with a cutoff $t(102) = 2.62$, $p \leq .05$. Achievement failed to predict performance within each condition. None of the comparisons were significant, largest $t = 2.04$ for the provided elaboration (PE) condition.

Quality of Generated Elaborations and Recall

The relation between the quality of generated elaborations in response to the "why" question in elaborative interrogation and recall was examined. The generated elaborations were categorized as being either "no response", where no attempt was made to provide an elaboration; "inadequate", where the elaboration was a simple restatement of the to-be-learned fact or did not contain information that reduced the arbitrariness between

the elements in the fact (i.e., imprecise); or "adequate", where the elaboration clearly specified the significance of the relation between the factual elements (i.e., precise). "Adequate" responses were further categorized as being either "adequate-correct", where the elaboration contained information that was factually correct about the animal being discussed; "adequate-incorrect", where the elaboration contained factually incorrect information about the animal, yet the to-be-learned information was made more meaningful; or "adequate-pat", where the elaboration was explanatory and factually correct, yet was general or vague enough to be true of another animal and hence would not have made the to-be-learned fact as meaningful.

Interrater reliabilities were established for the quality of elaboration scores. Over 30% of the elaborations were scored for adequacy by two raters who had experience in rating precision for at least two previous research projects. Reliabilities were calculated by dividing the number of agreements on scores made by the two raters and dividing this value by the total number of elaborations scored by the raters. There was over 95% agreement on the classification of elaborations as adequate or inadequate and over 96% agreement on the classification of the adequate elaborations were correct, incorrect, or pat. Differences were resolved by discussion.

Regardless of academic achievement, quality scores for the generated elaborations were significantly correlated with recall scores, $r = .60$ ($p \leq .001$, $df = 27$). Higher quality was defined as more precise which would predict better recall. Within the average achievement group, quality scores were significantly correlated with recall, $r = .61$ ($p \leq .05$, $df = 19$). The correlation between quality scores and recall failed to reach significance within the low achievement group, $r = .47$ ($p = .235$, $df = 7$).

Item-by-item conditional probabilities were calculated to determine the impact of quality of generated elaborations on recall. Conditional probabilities were calculated by matching the quality of elaboration for each animal fact with the corresponding recall item for each individual. These probabilities and mean adequacy scores are reported in Table Two.

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Insert Table 2 About Here

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Low and average achievers were contrasted in terms of quality of generated elaborations. Compared to the average achievers, low achievers were more likely to generate inadequate elaborations, $t(26) = 2.78$, $p \leq .05$). Although there was a trend for the academically successful students to generate more adequate elaborations than their less

successful counterparts, the difference was not significant, $t(26) = 1.67$. No other significant differences were observed between the low and average achievers in terms of quality of elaborations generated using elaborative interrogation.

In order to compare the results of the conditional probabilities for the response categories in elaborative interrogation with previous findings (Pressley, McDaniel, Turnure, Wood, & Ahmad, 1987; Pressley, Symons, McDaniel, Snyder, & Turnure, 1988; Woloshyn, Willoughby, Wood, & Pressley, 1990; Wood, Winne, & Pressley, 1990; ), data collapsed between ability levels were used. Then the same set of conditional probabilities were re-calculated within each ability level. Item-by-item conditional probabilities indicated that, regardless of academic achievement, the probability of recalling an item was greater if learners generated an adequate or an inadequate response than if they failed to respond, $t(71) = 4.19$ and 3.24, respectively ($p \leq .05$). In terms of the veracity of generated elaborations impacting on recall, it was found that overall, adequate-correct elaborations resulted in a greater probability of recall than adequate-incorrect elaborations, $t(80) = 2.62$, $p \leq .05$. Although there was a trend for greater recall given the generation of an adequate-correct elaboration rather than an adequate-pat elaboration, the comparison failed to

reach significance, largest $\underline{t}(80) = 2.13$ for scores collapsed across achievement.

These conditional probabilities were also calculated separately for the low and average achievement groups. There was no significant difference between the conditional probabilities for the adequate and inadequate categories within the low and average achievement groups, $\underline{t} = 1.73$ and .42, respectively. Within the low achievement group, the probability of correct recall was greater if students generated an adequate elaboration than if they failed to respond, $\underline{t}(18) = 3.24$, $p \leq .05$. Within the average achievement group, the probability of recall was greater if an adequate or an inadequate elaboration was generated than if learners failed to respond, $\underline{t}(50) = 3.25$ and 2.88, respectively ($p \leq .05$). Within the average achievement group, adequate-correct elaborations resulted in greater probability of recall than adequate-incorrect elaborations, $\underline{t}(57) = 2.57$, $p \leq .05$. This comparison failed to reach significance within the low achievement group. Although there was a trend in both the low and average achievement groups for greater recall given the generation of an adequate-correct elaboration rather than an adequate-pat elaboration, the comparison failed to reach statistical significance.

Quality of Provided Elaborations and Recall

Within the experimenter provided elaboration condition, students were provided with both precise and imprecise elaborations to base sentences (counterbalanced between lists) and asked to repeat the facts aloud. The quality of the provided elaborations did not impact significantly on the probability of correct recall both overall and within achievement levels, largest $t(36) = .52$ for the comparison of recall of precisely versus imprecisely elaborated information within the average achievement group (means for the low and average achievement groups, respectively were .44 and .53 for precise elaborations and .39 and .55 for imprecise elaborations). This finding indicated that learning may have been more difficult due to the incompatibility between the information and the learners' knowledge base.

Judgements of Provided Elaborations and Recall

In the judgement/analysis condition, students were provided with precisely and imprecisely elaborated sentences and asked to judge the adequacy of the elaborations. Specifically, they were asked to judge whether the provided elaboration adequately explained why that animal rather than any other animal would engage in the specified activity. Students used a binary coding system where a "good" evaluation represented an adequate explanation and a "poor"

evaluation represented an inadequate elaboration. They were also asked to justify/analyze their judgement of the provided elaboration. The analysis component of the task was included to ensure that students were expending an amount of cognitive effort that was comparable to that expended by learners in the EI condition when learning the new information. However, the analyses of judgements were inextricably tied to the judgements, hence a precise scoring criteria for generated analyses could not be established. Therefore, only results pertaining to the judgements of the elaborations are discussed.

If the judgement was identical to expert ratings of the elaboration, then it was scored as a "match". If the learner and expert ratings were discrepant, the judgement was scored as a "no match". A "failure to respond" category was included for the items that students failed to judge. Differences between the achievement groups in the frequency of these response categories were not significant.

Item-by-item conditional probabilities were conducted for the judgements in order to determine whether matching to expert ratings impacted on memory performance. Overall, the probability of correct recall was significantly higher if students' ratings of the elaborations matched expert ratings versus if they failed to respond, $t(71) = 2.90$, $p \leq .05$ ($M$ = .55 and .36, respectively). No other comparison was

significant. Within the average achievement group, the probability of correct recall was greater if the judgements matched expert ratings than if no judgement was made at all, $\underline{t}(49) = 2.49$, $\underline{p} \leq .05$. The other comparisons failed to reach significance for the average achievement group. There were no differences in probability of correct recall across categories for the low achievement group, largest $\underline{t}(19) = 1.39$, for the match versus failure to respond categories. Average students who actually make an assessment of the elaboration, perform better at recall than if they are unable to make any evaluation at all. For the low achieving students, any attempt to search the knowledge base in order to make a judgement would enhance recall. Therefore, any search of the knowledge base enhanced the performance of low achievers, yet the average achievers must be able to embed the new information into something meaningful within their semantic repertoire in order to perform well at recall.

Within the judgement/analysis condition, students matched expert evaluations for 64% of the data and they disagreed with 30% of the expert evaluations and failed to evaluate 6% of the elaborations. Given such a high proportion of disagreements, the possibility that students were unable to discriminate between the good and poor elaborations was considered. It could be argued that when students process the elaboration, they may interpret it in

terms of their own unique knowledge base in a different manner from the expert. If this were the case, it might be expected that students' own evaluations should be used to determine the impact of precision on recall. This possibility was assessed within the judgement/analysis condition. The data were reanalysed based on students' perceptions of the precision of the elaborations regardless of whether their perception matched expert ratings. Item-by-item conditional probabilities were calculated to determine the relation between students' evaluations of precision and subsequent memory performance. The conditional probabilities are reported in Table Three. The

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Insert Table 3 About Here

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probability of correct recall did not differ as a function of precision, regardless of ability, largest $\underline{t}(52) = 1.15$, $\underline{p} > .05$ for the comparison collapsed across achievement. This suggests that the poor performance in the provided elaboration conditions was not a product of discord between expert and student knowledge base. Students clearly had difficulty handling provided elaborations and as such, were ineffective at assessing the precision of the elaborations. Hence, students failed to compensate for poorly elaborated items.

## Discussion

Consistent with previous research, this study also demonstrated an advantage when using elaborative interrogation relative to the default rehearsal strategy when individual differences were not considered. As predicted, when assessed by academic achievement, the potency of the strategy was more apparent in the average achievement group. Although the low achievers tended to have enhanced memory performance when using the elaborative interrogation strategy, they were not able to use this strategy as effectively as the average achievers. One explanation for this finding might be that low achievers have a limited knowledge base for many topic domains. The efficacy of the elaborative interrogation strategy has been shown to be dependent on knowledge base (Martin & Pressley, 1991; Willoughby, Waller, Wood, & MacKinnon, in press; Wolcshyn, Pressley, & Schneider, 1992). Therefore, when generating responses to the "why" question in EI, low achievers who may have less relevant knowledge to access would fail to make meaningful connections between new information and existing knowledge and hence, would not benefit from using elaborative interrogation. In this study, low achievers did produce more inadequate elaborations suggesting that they were indeed experiencing difficulty generating adequate elaborations in response to

the "why" questions.

Another reason why low achievers failed to show the learning gains demonstrated by the average achievers using elaborative interrogation might be that the strategy training was insufficient. Academically successful students should be able to adapt to the learning situation quite easily because they are perhaps already familiar and fluent with other elaboration or associative strategies (Schneider & Pressley, 1989). Hence, the elaborative interrogation strategy would be more easily assimilated for this group. Less successful students, however, rarely use sophisticated strategies (Garner, 1990a; 1990b) and would most probably experience greater difficulty managing the demands required by the elaborative interrogation strategy. Perhaps more extensive training in this strategy would prove valuable. Wong and Sawatsky (1985) found that explicit training in strategy use was very effective for low achievers.

Although the efficacy of the elaborative interrogation strategy was not as apparent in the low achievement group, it might have been due to the small sample of low achievers. A small sample would not provide enough statistical power to pull out a significant effect. It might be the case that elaborative interrogation facilitates learning relative to simple repetition even in low achievers. Effect sizes (Cohen, 1965, 1969) were calculated in order to assess this

possibility. The effect sizes for the low and average achievement groups were comparable: performance in the elaborative interrogation condition exceeded that in the reading control condition by approximately 1.75 standard deviations for the average achievement group and 1.61 standard deviations for the low achievement group. The large magnitudes of both these effect sizes indicates that the benefits of elaborative interrogation relative to simple repetition are evident in both low and average achievers. Therefore, the elaborative interrogation strategy might have been found to be a good mnemonic facilitator even for low achievers if the power was sufficient enough to detect statistical significance.

Although recall scores were higher in the elaborative interrogation condition than in the judgement/analysis condition, the difference was not significant even within achievement levels. Since the cognitive effort expended in the two conditions was comparable, this trend indicates that elaboration via self-questioning enhances memory more than the active processing of provided information.

For both the low and average achievers, performance in the PE condition was not greater than that in the simple repetition condition (although there was a trend for recall performance to be greater in the PE condition). Within the PE condition, repetition of precisely elaborated information

failed to facilitate recall any more than repetition of imprecisely elaborated information regardless of academic achievement levels (although the trend was in the expected direction). An explanation for this finding might be that learners were unable to be selective in their attention and were perhaps not processing the connection that reduced the arbitrariness of the to-be-learned information. Bransford, Stein, Vye, et al., (1982) found that young students failed to allot enough time to process non-elaborated information. Perhaps even adolescent students are less able to identify the best ways to study and hence, are not selective enough in their processing of new information.

The findings in this study are consistent with the trend observed by Wood, Pressley, and Winne (1990) with the older students. Within both the average and low achievement groups, generating a response to the "why" question, whether adequate or inadequate, resulted in greater probability of correct recall than if a response was not made at all. Overall, it appears that adolescents are utilizing the elaborative interrogation strategy much like adults in that the quality of elaborations does not impact on recall when elaborations are classified as either adequate or inadequate (Pressley, McDaniel, Turnure, et al., 1987; Woloshyn, Willoughby, Wood, & Pressley, 1990). The impact of quality of elaboration on recall appears to be opposite for

adolescents compared to students who are much younger. Younger students recall more information when they generate adequate elaborations rather than inadequate ones and neither type of elaboration differs from failing to respond (Wood, Pressley, & Winne, 1990). Among the average and low achieving adolescents, generating an elaboration, regardless of its adequacy, resulted in greater recall than failing to respond. One interpretation of these findings might be that younger students may need to embed new information in something that is already meaningful in order learn the information, hence their recall performance is enhanced when they generate adequate as opposed to inadequate elaborations. When younger students fail to generate an elaboration, it might be that they are not processing the new information thoroughly and such partial processing may not be sufficient to allow the information to be embedded in the learners repertoire. Therefore, no differences are apparent in these young learners when they fail to generate an elaboration compared to when they generate an elaboration regardless of whether that elaboration is adequate or inadequate. The adequacy of generated elaborations may not be as crucial for older students whose performance is enhanced because generating an elaboration involves such thorough processing that the mere attempt to generate a response seems to facilitate their performance.

When adequate elaborations were scored as either correct or incorrect the result was that adolescents were more likely to recall facts when adequate-correct elaborations were generated as opposed to adequate-incorrect elaborations. This is consistent with the findings reported in the studies conducted with both adults and children.

From the results of the conditional probabilities, it appears that there are several parallels between the utilization of elaborative interrogation in adolescent and adult populations. This is plausible since the verbal proficiency of adolescents would be expected to be more similar to that of adults than children. The developmental implications for strategy use are quite consistent with an interpretation that knowledge base is the latent variable accounting for the efficacy of elaborative interrogation. Adults and adolescents, who presumably have a more expansive knowledge base, can easily make connections between new information and existing knowledge and hence, the adequacy of their elaborations may not be crucial for correct recall. Younger students, who have less developed knowledge bases, would have greater probability of correct recall when generating elaborations that are correct or at least adequate.

Siegler (1991) suggested that the learner's knowledge base provides a framework for organizing new information.

This study demonstrated that elaborative interrogation promotes that organization by encouraging learners to make connections between new information and their existing knowledge base.

Clearly, strategic learning is a complex activity. Much research in the last decade has investigated the interaction between knowledge base and strategy use (see Schneider & Weinert, 1990 for a review). This study was an initial attempt to delineate the interaction between academic achievement and strategy use in adolescents. The elaborative interrogation strategy has proven to be potent across age in that it can be implemented successfully from grade schoolers to adults.

## Footnotes

[1]In the Stein et al. studies, materials were comprised of sentences about men for which it is possible to generate a single answer that would clarify the relation between the type of man and the activity he was performing. In this study, animal facts were used for which there is more than one answer that would adequately explain the relation between the factual elements in the sentence. Therefore, in this study, the adequate/inadequate terminology was used for classifying elaborations rather than precise/imprecise.

[2]Students were classified as either low or average achievers based on their performance on a verbal proficiency test. Very few students met the criteria for the high achievement group and they were not included in the analyses given the small sample.

[3]These data could also have been analyzed using regression or ANOVA procedures. Dunn-Bonferroni planned comparisons were used here in order to parallel the published research on this topic, and to allow comparisons of patterns of results with those studies (e.g., Woloshyn et al., 1990; Wood et al., 1990).

## Appendix A. Examples of Factual Stories

### The Grey Seal (List I)

The grey seal lives on exposed rocky coasts because it lives near water. Each seal in the group lives on one special spot or rock because seals are territorial and that prevents them from hurting each other. The grey seal likes to live on the Maritime Coast where there are many rocky areas for the seal to consider home. The grey seal eats fish that are found on the bottom of the sea so it won't have to waste its energy catching other fish. The grey seal sleeps in shallow water because it is comfortable there. The one big danger for the grey seal is the killer whale which is one of the biggest meat eaters.

### The Grey Seal (List II)

The grey seal lives on exposed rocky coasts so that the sun can warm the rocks before it lies on them. Each seal in the group lives on one special spot or rock because it likes its privacy. The grey seal likes to live on the Maritime Coast because that is its habitat and it is a good place for it to live. The grey seal eats fish that are found on the bottom of the sea which it can easily dive down to get. The grey seal sleeps in shallow water so that it can come to the surface without having to wake up. The one big danger for the

grey seal is the killer whale because the killer whale is a miserable animal.

## Appendix B. Cued Recall Test Items

### Grey Seal

1. Which animal lives on exposed rocky coasts?
2. Which animal lives on one special spot or rock?
3. Which animal likes to live on the Maritime Coast?
4. Which animal eats fish that are found on the bottom of the sea?
5. Which animal sleeps in shallow water?
6. Which animal's one big danger is the killer whale?

### Townsend Mole

1. Which animal lives in tunnels?
2. Which animal especially likes to live in warm, humid areas?
3. Which animal usually prefers the Pacific Coast?
4. Which animal eats insects and grubs?
5. Which animal naps throughout the day?
6. Which animal has few dangers except for snakes?

### Emperor Penguin

1. Which animal lives only in Antarctica?
2. Which animal likes to live in the sea for a few weeks at a time?
3. Which animal never makes a nest or home to hide in?
4. Which animal eats squid and fish?
5. Which animal sleeps longer when it gets really cold?

6. Which animal's one danger is the leopard seal?

Little Brown Bat

1. Which animal lives in dark places like caves, attics, or abandoned houses?
2. Which animal lives with a few to several hundred animals?
3. Which animal lives in eastern Canada?
4. Which animal's favourite food is flying insects?
5. Which animal sleeps all winter?
6. Which animal has very few dangers except for weather?

Blue Whale

1. Which animal lives in the Arctic and Antarctic Oceans?
2. Which animal prefers to be near the surface of the water most of the time?
3. Which animal only eats for about three months of the year?
4. Which animal when eating, likes ocean plants and small, shrimp-like creatures?
5. Which animal sleeps by resting only half of its brain at a time?
6. Which animal's worst danger is being caught under the ice?

**House Mouse**

1. Which animal likes to live in warm, dry areas?
2. Which animal is most often found anywhere people live?
3. Which animal lives in southern Canada?
4. Which animal eats nuts, vegetables, fruits, and grains?
5. Which animal when tired, heads for its home which is usually a tiny hole or dark corner?
6. Which animal has many dangers like owls, hawks, and snakes?

**Swift Fox**

1. Which animal usually lives all by itself?
2. Which animal stays in a ready-made home like a small cave or hollowed out log?
3. Which animal's favourite place to find a home is near grassy areas?
4. Which animal, when hungry, eats rabbits, squirrels or mice?
5. Which animal is usually fast asleep during the daylight hours only?
6. Which animal is in danger from coyotes?

**Western Spotted Skunk**

1. Which animal lives in a hole in the ground?
2. Which animal often lives alone, but sometimes stays

together in families?

3. Which animal's hole is usually found on a sandy piece of farmland near crops?
4. Which animal mostly eats corn?
5. Which animal sleeps just about any time except between three o'clock in the morning and sunrise?
6. Which animal's biggest danger is the great horned owl?

American Pika

1. Which animal lives so high up in the Rocky Mountains that trees can't grow?
2. Which animal likes to live in and around rock piles?
3. Which animal is only found in British Columbia?
4. Which animal eats grasses and flowering plants?
5. Which animal sleeps during the night?
6. Which animal's most dangerous enemies are birds and weasels?

## References

Bransford, J.D., Stein, B.S., Vye, N.J., Franks, J.J., Auble, P.M., Mezynski, K.J., & Perfetto, G.A. (1982). Differences in approaches to learning: An overview. Journal of Experimental Psychology: General, 111(4), 390-398.

Cohen, J. (1965). Some statistical issues in psychological research. In B.B. Woleman (Ed.), Handbook of clinical psychology. New York: McGraw-Hill.

Cohen, J. (1969). Statistical power analysis for the behavioral sciences. New York: Academic Press.

Craik, F.I.M., & Lockhart, R.S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-684.

Franks, J.J., Vye, N.J., Auble, P.M., Mezynski, K.J., Perfetto, G.A., Bransford, J.D., Stein, B.S., & Littlefield, J. (1982). Learning from explicit versus implicit texts. Journal of Experimental Psychology: General, 111, 414-422.

Garner, R. (1990a). Children's use of strategies in reading. In D.F. Bjorklund (Ed.), Children's strategies: Contemporary views of cognitive development (pp. 245-268). Hillsdale, NJ: Lawrence Erlbaum.

Garner, R. (1990b). When children and adults do not

use learning strategies: Toward a theory of settings. Review of Educational Research, 60(4), 517-529.

Jacoby, L.L. (1978). On interpreting the effects of repetition: Solving a problem versus remembering a solution. Journal of Verbal Learning and Verbal Behavior, 17, 649-667.

Kirk, R.E. (1982). Experimental design: Procedures for the behavioral sciences (2nd ed.). Monterey, CA: Brooks/Cole.

Martin, V.L., & Pressley, M. (1991). Elaborative interrogation effects depend on the nature of the question. Journal of Educational Psychology, 83, 113-119.

Prescott, G.A., Balow, I.H., Hogan, T.P., & Farr, R.C. (1986). The Metropolitan Achievement Test. New York: Harcourt Brace Jovanovich.

Pressley, M., McDaniel, M.A., Turnure, J.E., Wood, E., & Ahmad, M. (1987). Generation and precision of elaboration: Effects on intentional and incidental learning. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 291-300.

Pressley, M., Symons, S., McDaniel, M.A., Snyder, B.L., & Turnure, J.E. (1988). Elaborative interrogation facilitates acquisition of confusing facts. Journal of Educational Psychology, 80, 268-278.

Pressley, M., Wood, E., & Woloshyn, V.E. (1990). In W. Schneider & R.E. Weinert (Eds.), Interactions among aptitudes, strategies, and knowledge in cognitive performance (pp. 200-221). New York: Springer-Verlag.

Rohwer, W.D., Rabinowitz, M., & Dronkers, N.F. (1982). Event knowledge, elaborative propensity, and the development of learning proficiency. Journal of Experimental Child Psychology, 33, 492-503.

Schneider, W., & Pressley, M. (1989). Memory development between 2 and 20. New York: Springer-Verlag.

Schneider, W., & Weinert, G.E. (1990). Interactions among aptitudes, strategies, and knowledge in cognitive performance. New York: Springer-Verlag.

Siegler, R.S. (1991). Children's thinking (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Slamecka, N.J., & Fevreiski, J. (1983). The generation effect when generation fails. Journal of Verbal Learning and Verbal Behavior, 22, 153-163.

Slamecka, N.J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. Journal of Experimental Psychology: Human Learning and Memory, 4, 592-604.

Stein, B.S. (1978). Depth of processing reexamined: The effects of the precision of encoding and test

appropriateness. Journal of Verbal Learning and Verbal Behavior, 17, 165-174.

Stein, B.S., & Bransford, J.D. (1979). Constraints on effective elaboration: Effects of precision and subject generation. Journal of Verbal Learning and Verbal Behavior, 18, 769-777.

Stein, B.S., Bransford, J.D., Franks, J.J., Owings, R.A., Vye, N.J., & McGraw, W. (1982). Differences in the precision of self-generated elaborations. Journal of Experimental Psychology: General, 111(4), 399-405.

Swing, S., & Peterson, P. (1988). Elaborative and integrative thought processes in mathematics learning. Journal of Educational Psychology, 80(1), 54-66.

Tyler, S.W., Hertel, P.T., McCallum, M.C., & Ellis, H.C. (1979). Cognitive effort and memory. Journal of Experimental Psychology: Human Learning and Memory, 5, 607-617.

Willoughby, T., Waller, T.G., Wood, E., & MacKinnon, G.E. (in press). The effect of prior knowledge and prose structure on immediate and delayed recall following training in elaboration. Contemporary Educational Psychology.

Willoughby, T., & Wood, E. (1992). Using visual adjuncts to facilitate prose learning with elaboration strategies. Paper presented at The Canadian Society

for Studies in Education Conference, Prince Edward Island, June.

Woloshyn, V.E., Pressley, M., & Schneider, W. (1992). Elaborative interrogation and prior knowledge effects on learning of facts. Journal of Educational Psychology, 84(1), 115-124.

Woloshyn, V.E., Willoughby, T., Wood, E., & Pressley, M. (1990). Elaborative interrogation facilitates adult learning of factual paragraphs. Journal of Educational Psychology, 82, 513-524.

Wong, B.Y.L., & Sawatsky, D. (1985). Sentence elaboration and retention of good, average and poor readers. Learning Disability Quarterly, 7, 229-235.

Wood, E., Pressley, M., Turnure, J.E., & Walton, R. (1987). Enriching children's recall of picture-dictionary definitions with interrogation and elaborated pictures. Educational Communication and Technology Journal, 35(1), 43-52.

Wood, E., Pressley, M., & Winne, P.H. (1990). Elaborative interrogation effects on children's learning of factual content. Journal of Educational Psychology, 82(4), 741-748.

Table 1

Mean Recall Scores Across Experimental Conditions and Academic Achievement Levels

| Achievement Level | | R | PE | J/A | EI |
|---|---|---|---|---|---|
| Low | Mean | 19.86 | 22.25 | 26.00 | 29.00 |
| | SD | 6.39 | 11.90 | 6.72 | 4.84 |
| | n | 7 | 8 | 8 | 8 |
| Average | Mean | 26.80 | 29.11 | 29.25 | 35.20 |
| | SD | 8.59 | 7.89 | 8.72 | 6.59 |
| | n | 20 | 19 | 20 | 20 |

Notes. Maximum score = 54 for each group. R = repetition control; PE = repetition of provided elaborations; J/A = judgement/analysis; EI = elaborative interrogation.

Table 2

Mean Percentage Recall Scores as a Function of Adequacy of Responses in the Elaborative Interrogation Condition

| Achievement Category | Frequencies | | | Conditional Probabilities | | |
|---|---|---|---|---|---|---|
| | n | Mean | SD | n | Mean | SD |
| **Collapsed:** | | | | | | |
| No Response | 28 | 4.14 | 6.51 | 18 | .41 | .29 |
| Inadequate | 28 | 17.96 | 7.97 | 28 | .60 | .17 |
| Adequate | 28 | 31.89 | 10.11 | 28 | .66 | .12 |
| Correct | 28 | 23.36 | 8.60 | 28 | .70 | .11 |
| Incorrect | 28 | 3.39 | 2.87 | 27 | .50 | .39 |
| Pat | 28 | 5.14 | 2.98 | 28 | .54 | .27 |
| **Low Achievement:** | | | | | | |
| No Response | 8 | 3.13 | 5.72 | 5 | .35 | .21 |
| Inadequate | 8 | 23.88 | 8.69 | 8 | .49 | .12 |
| Adequate | 8 | 27.00 | 11.33 | 8 | .62 | .13 |
| Correct | 8 | 19.75 | 9.57 | 8 | .67 | .12 |
| Incorrect | 8 | 3.00 | 2.67 | 7 | .55 | .36 |
| Pat | 8 | 4.25 | 3.15 | 8 | .45 | .32 |
| **Average Achievement:** | | | | | | |
| No Response | 20 | 4.55 | 6.90 | 13 | .43 | .33 |
| Inadequate | 20 | 15.60 | 6.46 | 20 | .64 | .18 |
| Adequate | 20 | 33.85 | 9.16 | 20 | .67 | .11 |
| Correct | 20 | 24.80 | 7.97 | 20 | .71 | .11 |
| Incorrect | 20 | 3.55 | 3.00 | 20 | .48 | .41 |
| Pat | 20 | 5.50 | 2.91 | 20 | .58 | .25 |

Table 3

Mean Percentage Recall Scores as a Function of Judgements Made in the Judgement/Analysis Condition

| Achievement Category | Conditional Probabilities | | |
|---|---|---|---|
| | n | Mean | SD |
| **Collapsed:** | | | |
| Elaboration Rated as Poor | 27 | .56 | .17 |
| Elaboration Rated as Good | 27 | .50 | .17 |
| **Low Achievement:** | | | |
| Elaboration Rated as Poor | 8 | .51 | .16 |
| Elaboration Rated as Good | 8 | .47 | .16 |
| **Average Achievement:** | | | |
| Elaboration Rated as Poor | 19 | .58 | .18 |
| Elaboration Rated as Good | 19 | .52 | .18 |