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FACILITATING CHILDREN'S FACT ACQUISITION

USING ELABORATION STRATEGIES

by

Eileen Joyce Wood

H. B. A. University of Western Ontario, 1983

M.A. University of Western Ontario. 1985

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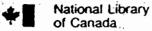THE REQUIREMENTS FOR THE DEGREE OF

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                              ii

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Facilitating Children's Fact Acquisition

Using Elaboration Strategies

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ABSTRACT

School children are constantly faced with the difficult task of learning and remembering facts. Research with adults implicates elaboration strategies as powerful mediators for fact acquisition. Evidence suggests that these same elaborative strategies may also be effective for children. That children need to learn facts, and that they may be able to do so efficiently using elaboration, motivated this study of elaboration strategies for acquisition of factual content.

In two experiments children in grades 4 to 8 learned facts presented through sentences. Children were placed in one of several instructional conditions. In the base control condition, children were given the sentences with instructions to study them in whatever manner they wished. In another condition, children were given elaborated versions of the base sentences. These children were instructed to note how the elaboration made the facts easier to understand (the elaborations explained the relationship between the pieces of information in the sentence). Children in the elaborative interrogation condition were asked to generate their own elaborations in response to a why question following presentation of the fact in a base sentence (the questions asked "Why would that fact be true?"). Children in imagery conditions were asked to create mental representations of the facts presented in base

sentences. All children were tested for their recall of the sentence facts after they studied.

In Experiment 1, the study sentences contained completely arbitrary factual relationships. In Experiment 2, the relationships were less arbitrary and more representative of school tasks (i.e., the children learned animal facts).

Elaborative interrogation consistently enhanced acquisition of the facts. Although there were some differences in recall performances in the other conditions when compared to the base control condition, none of these improvements was statistically reliable across both experiments. Subsequent analysis of the responses to the "why" questions (i.e., answers to questions during study) in the elaborative interrogation condition suggested that the type of elaboration the child generated at study could affect later recall. For younger children, it was especially important that their answers explain the relationship of the sentence facts accurately. These findings are discussed with respect to their developmental implications and are contrasted with existing empirical and theoretical expectations.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

x

CHAPTER I

INTRODUCTION

Learning and remembering what has been taught are daily
events for the school child. Over the past two decades much
research has focused on developing instructional procedures
to enhance the child's ability to acquire and recall
relevant information (for example, see Pressley & Levin,
1983). A great deal of attention has been directed toward
investigating the role of children's prior knowledge for
facilitating acquisition. Research has focused on a number
of issues, ranging from studies investigating the manner in
which existing knowledge influences acquisition of novel
information, to the frequency with which children engage
prior knowledge to assist in learning, to research like the
present study on the effects of strategies that encourage
the use of prior knowledge.

Children's prior knowledge can mediate learning. For
example, Brown, Smiley, Day, Townsend and Lawton (1977)
demonstrated the effect of prior knowledge for memory of
text. Children were tested for their recall of a passage
about a fictitious Indian tribe. One week prior to testing,
children were divided into three groups with one group of
children being taught that the tribe was war-like, one being
taught that the tribe was peaceful, and one receiving no
prior lesson about the Indians. Memory for the information
was greater for the two groups who had some prior knowledge
in comparison to the group which had no prior knowledge.

Errors in recall also differed systematically in that the children's prior beliefs about the Indians were evident in the types of errors the children were likely to produce --- children who believed the Indians were war-like had distortions consistent with that belief and vice versa.

Although studies with children and adults (for example see Steffensen, Joag-Dev, & Anderson, 1979) demonstrate that prior knowledge does affect the manner in which information is acquired, it is clear that children do not spontaneously employ existing knowledge to the extent that they could. However, children can be prompted to use prior knowledge more frequently if explicitly trained to do so (see Hansen & Pearson, 1983).

Since prior knowledge does have reliable effects on memory, it is not surprising that research in strategy instruction has focused on ways to promote the use of prior knowledge. Recently, research has stressed the importance of employing elaboration strategies to enhance the acquisition of facts. The study of elaboration strategies is intriguing because they are sophisticated strategies (compared to rehearsal, for example) that are well matched to associative tasks like fact learning. Elaborations that are generated by or provided to the learner often promote retention of to-be-learned materials through the application of prior knowledge.

Fact learning is a frequent and difficult task in grade school and hence the introduction of strategies that assist

in fact acquisition should be welcome. Elaboration
techniques have a long history of success in improving
various types of factual learning. The specific techniques
range from ancient procedures such as the method of loci to
more recent vocabulary learning strategies such as the
keyword method (see Pressley, Levin, Hall, Miller, & Berry,
1980, for example). The use of mnemonic techniques is
particularly appropriate with children because grade-school
children rarely employ sophisticated strategies
spontaneously to acquire information that requires learning
of associations (Pressley, 1982).

The child is the 'perpetual' novice who regularly
encounters new domains that require the acquisition of a
series of new facts, concepts, and vocabulary items.
Initially, the new domain may appear to abound with
information that seems somewhat arbitrarily related and,
hence, is difficult to learn. In order for the novice to
understand the information she or he can try to link to-be-
learned items together meaningfully. Elaboration strategies,
and verbal elaborations in particular, provide a means for
the novice to draw upon relevant prior knowledge to relate
the items of the new domain. The specific concern
addressed in the present research was with one particular
elaboration strategy that can be used to assist children in
acquiring new information.

Precise Elaborations

Bransford, Stein and their colleagues have studied the potency of "precise" elaborations for facilitating acquisition of arbitrarily related facts. The term precise describes an ideal relationship between the components of to-be-learned facts. A precise elaboration enhances the significance and reduces the arbitrariness of the relationships to be learned. For example, in the following two sentences the relationships between the type of men and the activity in which the men are engaged seem somewhat arbitrary:

"The tall man bought the crackers."

"The sleepy man bought the mug."

When the sentences are precisely elaborated, the relationships appear less arbitrary:

"The tall man bought the crackers <u>that were on the</u> <u>top shelf</u>."

"The sleepy man bought the mug <u>filled with coffee</u>." Using the terminology of Bransford, Stein and colleagues, these elaborations are precise because they clarify why it would be relevant for the one particular type of man to engage in the specified activity.

Bransford (1979) hypothesized that the quality of elaborations would have a predictable influence on recall in fact learning. He suggested that different kinds of elaborations could either enhance or impede recall, and he predicted that precise elaborations would be the most

effective elaborations for enhancing learning and retention. Bransford, Stein, and their colleagues investigated the efficacy of precise elaborations for adult and fifth grade populations focusing primarily on the retention gains made available when precise elaboration was employed. The work with adults was extended in later studies examining the value of precise elaboration relative to other strategies.

Adult Studies of Precise Elaborations. There are reliable differences in recall performance as a function of precision in elaborations. In three studies in which adults generated elaborations for sentences (like the man sentences presented earlier), Stein and Bransford (1979) concluded that recall was higher following production of precise elaborations than following production of imprecise elaborations. Even when the imprecise elaborations were "associatively related" or "semantically congruous" to the information to be learned greater retention was associated with greater precision of elaboration (Stein, Littlefield, Bransford & Persampieri, 1984). In other words, sentence extensions that were consistent in meaning, or that were related to activity of the base sentence (for example, "The tall man bought the crackers that were on sale."), were less powerful than precise elaborations. However, the differences in recall between precisely- and imprecisely-elaborated content were not always great, particularly when adults generated their own elaborative extensions.

In the first two of these three studies, groups of
undergraduate students were exposed to different types of
elaborated sentences. The sentences contained elaborations
which were either high or low in associative relatedness to
the target information (the base sentences). Also, the
sentences contained elaborations that either clarified
(precise) or did not clarify (imprecise) the relationship
between the man and the activity. Recall was measured
following an incidental learning task. Precision was
expected to improve recall because the relationships between
the concepts and the retrieval cues were made less
arbitrary. Based on earlier work it was suggested that the
more highly associated elaborations might enhance recall
because the elaborations serve as cues for the learner to
"reinstate" the encoding context at the time of testing
(Craik & Lockhart, 1972). Consistent with Bransford's theory
of precision, precision facilitated retention while
associative relatedness did not affect it. Recall was not
affected in the second study even when the provided
elaborations contained related associations for both
components of the sentence (the man and the type of
activity) instead of just the type of man.

The third study replicated the first two studies but
extended the findings across a different type of retrieval
task. A recognition task was used to determine whether the
presence of elaborations at testing would facilitate
retention. Again, a strong effect was obtained only for

precision. Only elaborations that reduced the arbitrariness of relationships consistently produced strong retention gains.

Are precise elaborations more beneficial for retention when they are provided or when they are generated by the learner? Stein and Bransford (1979) investigated the effects of provided and self-generated elaborations on retention. They found positive effects for retention both when adults actively participated in the generation of precise elaboration and when adults read provided precise elaborations. In their first study undergraduates were presented the "man" sentences. Some subjects viewed sentences which provided ready-made precise elaborations. Other subjects in an elaborative interrogation condition were required to respond to a "why" question which asked them to clarify why that type of man would engage in the activity.

The self-generated elaborations in the elaborative interrogation condition and the provided precise elaboration condition resulted in substantial recall gains in comparison to the base condition, but did not differ from each other. A second study replicated these findings and implicated precision in the self-generated elaborations as a mechanism facilitating recall. That is, the generation of imprecise elaborations was associated with poorer recall than provided precise elaborations, but recall following the generation of precise elaborations did not differ from that of the

provided precise elaboration condition. These findings suggest that precision predicts recall rather than the source of the elaboration (whether it is self-generated or provided). This conclusion is possibly incorrect, however. The recall means for these two groups were extremely high (8.47 versus 8.33 out of 10 for the provided precise elaboration and the self-generated elaboration conditions respectively), and thus, there may have been a ceiling effect. This limits confidence in conclusions about the effect on recall of the source of elaboration.

Pressley, McDaniel, Turnure, Wood and Ahmad (1987) also compared provision versus generation of elaborations with adults to provide more definite findings than Bransford and Stein. In their first study subjects were exposed to 24 sentences and were given incidental learning instructions similar to those used by Bransford and Stein. There were no ceiling effects. Pressley et. al. (1987) found that adults who were asked to produce precise elaborations in response to "why" questions (i.e., in an elaborative interrogation condition) recalled more than peers who read provided precise elaborations, although providing precise elaborations facilitated recall relative to a base sentence control condition.

Pressley et. al. (1987) also made the self-generated versus provided versus control comparisons in an intentional learning situation where adults were informed of the recall test. The adults' recall in the self-generated condition

exceeded both of the other two conditions. Recall in the provided elaboration condition did not exceed the base condition, as it had in the earlier experiments, presumably because base control subjects in the intentional learning situation were generating strategies to mediate learning. Post-experiment interviews indicated greater use of strategies by intentional base controls than by incidental base control participants.

In summary, precise elaborations either provided or self-generated positively affect retention in incidental learning situations with adults. During intentional learning, when adults are more likely to use memory strategies on their own to mediate learning, the advantages of provided precise elaborations are minimal but self-generated elaborations still promote learning relative to an intentional control condition.

Precise Elaborations and Children. The research with school-age children, to date, was conducted almost exclusively with fifth grade children. Bransford and his colleagues argue that providing precise elaborations can facilitate learning in novices, and that since grade-five students are often in the position of being novices, their learning is improved by provision of precise elaborations.

Novices must acquire a series of new facts, concepts, and vocabulary items when they encounter a new domain. Initially, the new domain may appear to be filled with information that is arbitrary and, hence, difficult to

learn. In order for the novice to understand the
information, s/he must be able to link items together
meaningfully. Precise elaborations provide a means for the
novice to draw on existing relevant information to relate
items in the "new" domain coherently. Research using the
"man" sentence-learning paradigm has attempted to mirror the
kinds of constraints faced by the novice learner. The
research to date suggests that precise elaborations can
facilitate learning in some circumstances. Both children and
adults demonstrate some gains in retention when generating
precise elaborations, and less academically successful
students experience improved memory when taught to generate
precise elaborations for simple prose (Franks, Vye, Auble,
Mezynski, Perfetto, Bransford, Stein, & Littlefield, 1982).

Bransford and colleagues have been primarily interested
in the benefits of precise elaboration for academically
successful and less successful child learners. Observations
of academically successful children indicated that they
relate new information to existing knowledge, that they make
use of illustrations and other provided materials, and that
they are more active, whereas less successful peers tend
only to do repeated readings (Bransford, Stein, Vye, Franks,
Auble, Mezynski, & Perfetto, 1982). Elaboration by successful
students seems to aid retention. These types of observations
motivated them to undertake a further series of studies to
determine exactly how the relationship between precise
elaborations and children's learning could be described.

In particular, the self-questioning of successful students suggested that they may produce precise elaborations on their own; in contrast, less successful peers would not do so (Stein, Bransford, Franks, Vye, & Perfetto, 1982). It was hypothesized, therefore, that academically successful students would do well on fact learning tasks regardless of whether precise elaborations were provided at study. That is, provision of precise elaborations was unnecessary because students would presumably generate them on their own. Less successful students would be expected to show improvements when precise elaborations were provided since they fail to engage in elaboration spontaneously.

These hypotheses were tested using an incidental sentence rating task (using sentences similar to those mentioned earlier) with fifth graders. The fifth graders were presented 10 sentence pairs. One sentence in each pair was precisely elaborated and one sentence was imprecisely elaborated. Children were asked to rate the sentences as difficult or easy to understand and remember. Following a recall test, children were asked to rate a second set of 10 sentences and were again tested for recall. In this study, recall of elaborated sentences was better than recall of non-elaborated sentences for both groups of children. That is, whatever the good learners were doing on their own, it was not as effective as processing precise elaborations that were provided.

Another set of studies demonstrated that less academically successful fifth graders fail to generate precise elaborations spontaneously. When asked to generate elaborations for seemingly arbitrary sentence relationships, less successful fifth graders produced more imprecise elaborations than their average or more academically successful peers. In addition, performance was enhanced when the less successful children were given training and explicit instructions about the relationship between precision and retention (Stein, Bransford, Franks, Owings Vye, & McGraw, 1982).

A third series of studies compared the performance of fifth graders (academically successful vs. less successful) on their reading, studying and recall of two different stories (Franks, Vye, Auble, Mezynski, Perfetto, Bransford, Stein, & Littlefield, 1982). One version of each story was explicit, which meant that the key relationships were precisely elaborated. The second version of each story was implicit, since the relationships were not elaborated.

Less successful students spent the majority of their resources (time) reading and studying the explicit passages, the passages containing all the information and memory aids. This meant that they spent less time reading and studying the implicit passages which required further elaboration in order to be understood. This allocation of time and study effort produced low recall in these students. In contrast, successful students tended to allocate more study time to

the implicit passage and less time to the explicit passage, which produced higher recall of the arbitrary materials by these students.

In a follow-up study less successful students were given a pre-test; then they were trained to generate elaborations to arbitrary sentences. There were pretest to posttest gains suggesting again that precise elaboration skills can be trained and that production of precise elaborations enhances retention.

Bransford and his colleagues' findings have been replicated by other researchers who have employed similar materials and testing procedures. Most notably, Wong and Sawatsky (1984) contrasted the recall performance of academically successful, less successful, and average students following a sentence completion task. The incidental instructions required that the child write extensions for the "man" type base sentences. Academically successful children produced more precise elaborations and recalled more than their average and less academically-competent peers. This study also tested children across grades 5 through 7, although possible developmental differences were not assessed in these studies.

The present research seeks to explore more completely the potential of provided elaborations for enhancing children's learning. Existing studies have suggested that providing precise elaborations for fifth grade chidren can enhance retention performance. One problem with this

research is that it cannot be generalized. Although Bransford, Stein and associates have implied that precise elaboration effects would generalize across age, their testing procedures between ages have differed (incidental vs. intentional learning) and the populations tested are restricted (fifth graders and introductory psychology students). Moreover, since Bransford's studies have generally tapped only the extremes of normal classrooms (academically successful versus less academically successful students), these findings may not apply to "average" fifth grade populations. If precise-elaboration interventions are to be used for educational purposes, it would be valuable to know how precise elaboration affects the entire range of ability and grade levels.

The present study of intentional learning sought to distinguish the effects of provided precise elaborations for children in the fifth to eighth grade (in general, children between 8 1/2 and 14 years of age).

Contrasts With Other Strategies

In addition to including average children and sampling a wider range of ages, another goal of the present research is to contrast generation of precise elaborations with other elaboration and mnemonic strategies. This feature is included because there is some indication in the existing literature that provided precise elaborations may not be as effective as other elaborative strategies (e.g., Pressley et. al., 1987).

Elaborative Interrogation. Questioning has often been recommended as an important instructional strategy which, when properly structured, may lead to improved memory performance (for example see, Anderson & Biddle, 1975; Winne, 1979). Some advocates for questioning make strong claims about the potency of interrogation (see Graesser & Black, 1985 for examples) but recent evaluations suggest important but more limited effects (Redfield & Rousseau, 1981). Nonetheless, studies involving children from the grade school years (Ross & Killey, 1977; Pressley & Bryant, 1982) to preschoolers (Wood, Pressley, Turnure, & Walton, 1987) consistently support the efficacy of asking questions to enhance recall (although the robustness of the questioning effects varies across age and studies). Similarly, there is the consistent argument that higher-order questions enhance retention more so than factual level questions because higher-order questions require analysis or synthesis of information and encourage the learner to go beyond the information that is presented. When performance with these questions is contrasted with performance following factual level questions, recall is greater for information related to the higher-order questions than for information related to the knowledge level questions (Benton, Glover, Monkowski, & Shaughnessy, 1983).

One particular type of higher-order question was studied here. The "why" questions presented in the elaborative-interrogation condition required the learner to

draw upon prior knowledge to clarify seemingly arbitrary

relationships (e.g., "Why would it be that the tall man

bought the crackers?"). To answer a "why" question, the

learner must systematically analyze the new information and

relate it to knowledge in long-term memory. Answering such

questions requires understanding the significance of the

information to be learned, and it is this understanding (as

opposed to rote rehearsal) that can be called upon at

testing to aid retrieval of the entire fact given some part

of it.

Imagery. In addition to verbal elaboration strategies,

such as provision of precise elaborations and elaborative

interrogation, imagery strategies often facilitate retention

of verbal materials as gauged in pretest to posttest

comparisons (Richardson, 1976) of individual subjects and in

between-condition comparisons (see Bower 1969, for an

example). The effects have been found for a variety of

tasks; for example, free recall (Richardson, 1976) and

recognition memory (Bower, 1969).

Imagery was selected as a strategy to compare to

provision of precise elaborations and elaborative

interrogation because it is particularly well suited to

tasks requiring associative learning and because it is a

chunking mechanism that encourages the integration of

information (Paivio & Begg, 1981). Particularly relevant

here, Pressley and his associates (Pressley, McDaniel, et.

al., 1987; Pressley, Symons, et. al., 1988) found imagery to

be an effective strategy for adults who are learning
Bransford-type "man" sentences (i.e., subjects imagined the
particular type of man doing the action specified). Using
imagery, adults were able to acquire the pairings between
the men and their activities more quickly than adults
provided with precise elaborations or adults who received
no-strategy instruction. However, there are no guarantees
that imagery would mediate children's learning. For example,
through studies of paired-associate learning with
elementary-school-aged children, Pressley and Levin (1977)
observed some developmental constraints on the effectiveness
of employing imagery. Performance for younger children
(i.e., 7- to 8- year olds) was contingent on factors such as
presentation rate and concreteness of the stimulus pairs.
More specifically, younger children required slower
presentation rates and a greater degree of concreteness than
their older peers (i.e., 11- to 12- year olds). This finding
is consistent with other findings that more "imageable"
stimuli permit easier construction of an integrated image,
and hence subsequent recall that can be mediated by imagery
is more likely to be facilitated with relatively easier-to-
image compared to harder-to-image stimuli (see Pressley,
1977; Paivio & Begg, 1981).

The present study involves highly concrete materials,
with a presentation rate sufficiently slow (i.e., slower
than the slowest rates used in studies of paired-associate
learning) that children should be able to generate

integrated relationships between the men and activity
pairings (Pressley & Levin, 1977). Given the success of
imagery with adult learners, and given that learning the man
sentences is a task with parallel demands to that found in
previous research with children (for example, Pressley,
1976, required children to imagine actions presented in
concrete prose), there is reason to be optimistic that this
procedure would facilitate children's learning.

In summary, the present research was designed to
explore the role of provided precise elaborations,
elaborative interrogation, and imagery more completely than
was the case in previous research. The previous research
comparing these strategies was conducted primarily with
adult populations; most was conducted with materials that
are far removed from materials children would typically
encounter in the classroom. Although it might be assumed
that the laboratory tasks that predominated in previous
research tap the same processes as would be found in
educationally relevant materials, the applicability of these
findings to the classroom environment remains in doubt until
there are experiments in which the relative effects of
provided precise elaboration, elaborative interrogation, and
imagery are evaluated with more relevant materials presented
to school-aged learners.

CHAPTER 2

EXPERIMENT 1

The present study addresses the retention produced by three strategies across a range of school grades. The three strategies, provided precise elaboration, imagery, and elaborative interrogation, have been investigated individually, but have not been compared explicitly with children. In order to be continuous with previous adult research, these strategies were first tested using the same "man" type sentences employed in earlier studies. The memorial demands in the present study were reduced slightly compared to the adult study, however, after pilot testing indicated that the number of sentences used in some of the adult studies (i.e., 24 in Pressley et. al., 1987) was too great for younger children. In order to ensure that the children could perform the task with some success (i.e., floor effects could be avoided), the number of sentences presented was limited to 18.

Method

Subjects

The participants were 139 elementary school children (77 males and 62 females) attending a public school in Ontario. The children were drawn from grades four, five, six, seven and eight (age range from 9 years 1 month to 14 years 8 months) with approximately equal numbers of each sex and each grade represented in each of four experimental conditions: base, precise elaborations provided, imagery,

and elaborative interrogation. The children were randomly
assigned to conditions with approximately equal numbers of
children in each cell (35, 35, 35, and 34 subjects per cell
respectively). Due to equipment failure, the data for one
child was lost from the elaborative interrogation condition.

Materials

Three sets of stimulus materials were constructed. Each
set was a deck of 21 white cards, 12 cm x 19 cm with one
sentence typed on each card in capital letters. The first
three cards of each deck were used as examples and the
remaining 18 cards served as the sentences to be learned.
Each sentence described a particular type of man and the
type of activity in which the man was engaged. The type of
man and the activity were arbitrarily related in that there
was no intrinsic connection between the specified type of
man and the particular activity. Some of the sentences in
each set were used by Stein et. al. (1984) (7 sentences)
and the remainder (14 sentences) were devised by Pressley
et. al. (1987).

One set of cards was used for both the base and imagery
conditions (see Appendix A for the complete list of
sentences). Sentences on these cards contained simple
declarative statements describing the man and the activity.
Each sentence was underlined. For example, the three sample
base sentences were:

THE BALD MAN USED THE PHONE.

THE SAD MAN LOOKED AT HIS NEW BOAT.

<u>THE DYING MAN USED A FEATHER.</u>

Another set of cards were used for the provided precise-elaboration condition. These cards contained the same underlined base sentences followed by a nonunderlined precise elaboration (see Appendix A for the complete list of precisely elaborated sentences). The precise elaborations for the three sample sentences were:

<u>THE BALD MAN USED THE PHONE</u> TO CALL ABOUT THE HAT SALE.

<u>THE SAD MAN LOOKED AT HIS NEW BOAT</u> THAT HAD BEEN DESTROYED BY A TIDAL WAVE.

<u>THE DYING MAN USED A FEATHER</u> TO SIGN HIS WILL.

The precise elaboration reduced the arbitrariness of the relationship between the man and the activity by presenting an answer for the question, "Why would that man do that particular thing?". The precise elaborations had been used by Stein et. al. (1984) and Pressley et. al. (1987) in their previous work.

The remaining set of cards was used for the elaborative-interrogation condition. Each card contained the underlined base sentences with the question, "Why did that man do that?" typed below each statement. The examples were:

<u>THE BALD MAN USED THE PHONE.</u>

WHY DID THAT MAN DO THAT?

<u>THE SAD MAN LOOKED AT HIS NEW BOAT.</u>

WHY DID THAT MAN DO THAT?

THE DYING MAN USED A FEATHER.

WHY DID THAT MAN DO THAT?

All materials were presented in a constant order over trials and between sets. Each set had a corresponding taped presentation with a male voice reading the typed information. One sentence was heard/read every 15 seconds. (This presentation time was determined after extensive pilot testing.) Students in the imagery condition were provided with 22 cm x 25 cm line drawings to depict each of the three sample sentences (see Appendix B for drawings). Students' answers to "Why" questions in the elaborative-interrogation condition were recorded on a portable tape recorder which was placed in full view of the child.

The recall test consisted of 18 questions, one for each of the 18 sentences to be learned (see Appendix C for the recall items). Given an action, the child was asked to recall the man who did it. Recall questions were presented in a different random order for each subject.

Procedure

Each child was tested individually in a familiar room within their school. All children were informed that their task was to remember 18 sentences after reading/hearing them for 15 seconds each. The three examples in each set were used to demonstrate the procedure and presentation of the sentences. In all conditions, participants were instructed to read the sentences while they listened to the taped presentation.

Upon entering the testing room all children were introduced to the task. Children in the base condition were instructed as follows:

Today I'm going to show you some sentences about
different kinds of men. Every man will be doing
something different. Each sentence will be about one
type of man doing one thing. It's your job to
remember what each kind of man was doing in the
sentence.

Children in the precise-elaboration-provided condition were informed that the nonunderlined part of the sentence (the precise elaboration) would help them to remember the underlined part of the sentence. They were instructed to read the whole sentence when they tried to learn it:

One good way to help you to remember the kind of man
and what he was doing is to look at the last part of
each sentence, the part that isn't underlined. The last
part of the sentence tells why it was important that
only the one kind of man would do that kind of thing.
If you read why that kind of man would do that kind of
thing it will help you to remember the sentences.

Children in the imagery condition were instructed to create interactive images of exactly what was depicted in the sentence:

One good way to help you remember the the kind of man
and what he was doing is to make up a picture in your
head of the kind of man and what he was doing. An

especially good picture to make up would have the

special man doing exactly what the sentence says he is

doing. If you can think up this type of picture it will

help you to remember the sentences.

Children in the elaborative-interrogation condition

were asked to answer the "why" question below each sentence.

Children were further instructed that their answer would be

a "good" answer if it explained the relationship between the

type of man and the activity in which he was engaged.

Following the description of the sentences, these children

were told that, "After each sentence you will be asked to

answer a question." They were also told that, "Each question

will ask "why is it that the special man is doing the thing

that he is doing in the sentence." Then, like the other

groups they were told how the questions would help them. The

exact instructions were as follows:

One good way to help you remember the kind of

man and what he was doing is to answer the

questions. An especially good answer tells why it

was important that only the one kind of man would

do that kind of thing. If you can say why that kind

of man would do that kind of thing rather than some

other kind of man, it will help you to remember the

sentences.

Children were then given practice with the three sample

sentences. Children in the base condition were told to do

what they could to remember the sentences but no further

instruction was given for learning the materials. Children

in the precise elaboration condition were reminded to read

the whole sentence. After each sample sentence the

experimenter reiterated the value of the precise

elaboration:

That sentence is good because it tells you why a

(type of man) man and not any other man would (type

of activity).

In the imagery condition, feedback was provided for the

three sample sentences on the appropriateness of the

pictures they described. If the child included both the man

and the activity in their descriptions of the picture in

their head, they were told that they were doing well and

were shown the sample drawing (Appendix B) as follows:

That's a good picture because it has the

special kind of man and what he was doing. It's like

my picture because it has the (type of man) man and

what he was doing (activity).

If a child failed to include either the man or the

activity, s/he was prompted to include the missing item.

When the item was included, the child was shown the sample

picture:

That's a good picture that you have made up

but it doesn't really have (the _____ man) (the

activity). Can you think of another picture that has

both the man and what he was doing? .... Here's my

picture. Yours is like mine because it has the kind of man and what he was doing.

In the elaborative-interrogation condition children's responses to the three example sentences were prompted until a 'good' elaboration was produced (i.e. one that reduced the arbitrariness of the relationship between the man and the activity). When the children were successful on their first attempt they were told that their answer was appropriate. They were then shown the prepared precise elaboration as an alternate example:

> That answer is good because it tells you why it is important that a (type of man) man and not any other man would (type of activity). My answer is like that too. (Read sample answer) It's good because it tells you why it is important that a (type of man) man and not any other man would (type of activity).

If a child failed to produce an appropriate answer, s/he was given one or two prompts (if needed) to produce a better answer. After producing an appropriate answer, the child was shown the sample elaboration/answer as described earlier.

> That's a good answer but but it doesn't really tell us why it is very important that a (type of man) man and not any other man would (type of activity). Can you think of another answer that would tell you why it is important that a (type of

man) and not any other man would (type of

activity)?

Children were given practice on a sample recall task so

that they understood the criterion test for which they were

preparing. The three sample recall questions were asked and

children were corrected if they made an error:

WHO USED THE PHONE?

WHO LOOKED AT HIS NEW BOAT?

WHO USED A FEATHER?

Children were reminded of the instructions before

preceding to the 18 to-be-learned sentences. No feedback of

any kind was provided during study. Children in the imagery

condition were not asked to describe their images as they

studied.

The 18 to-be-learned sentences were presented

immediately following the instructions. The cued

recall task (18 "who" questions) was given immediately after

study in all conditions. Children were given 20 seconds to

generate an answer for each of the 18 test questions. After

20 seconds had elapsed the child was reminded of the

question and again asked to generate an answer.

Results

The principal analyses were performed on the recall

data with subsidiary analyses on the responses to the

questions during study in the elaborative interrogation

condition.

Recall Data

Recall responses were scored as correct if they were verbatim matches to the descriptions of the men presented at study or if they were approximately synonymous with the original wordings. For example, "mean man" was accepted as equivalent to "evil man". Two raters scored over 25 percent of the recall responses with over 95 percent agreement. The remaining data were scored by one of the two raters.

The overall experimental group recall means are recorded in the first column of Table 1. Effect sizes were calculated to determine the magnitude of the differences in the mean scores (Light & Pillemer, 1984). The mean score for the base reading condition was subtracted from the mean of each of the remaining conditions, then each of these differences was divided by the square root of the mean square error (see Table 2 for effect sizes). The largest effect size occurred in the elaborative interrogation condition with older children (2.31 SD's) and the smallest effect size was for young children given the provided precise elaborations (.54 SD's).

The mean scores of each the four recall means were contrasted pairwise using a set of 6 Dunn-Bonferonni contrasts (overall Type 1 error rate < .05, p < .0083 per comparison; cutoff t = 2.68). Recall in the elaborative interrogation condition exceeded recall in both the provided precise elaboration and base sentence conditions, smaller t(135) = 4.10, but not in the imagery condition, t(135) =

TABLE 1

Mean Recall of the Man Sentences for Younger and Older

Children

Condition	Overall[a]	Age	
		Younger than Median[b]	At or Above Median[c]
Base Sentences			
$\bar{X}$	7.26	7.72	6.77
SD	3.23	3.29	3.19
n	35	18	17
Provided Precise Elaborations			
$\bar{X}$	9.89	9.60	10.10
SD	3.58	3.60	3.64
n	35	15	20
Imagery			
$\bar{X}$	11.83	11.06	12.65
SD	4.19	3.61	4.70
n	35	18	17
Elaborative Interrogation			
$\bar{X}$	13.47	11.29	15.00
SD	3.44	3.47	2.51
n	34	14	20

Note. Median age = 11 years and 7 months
[a]Mean Square Error = 13.17
[b]Mean Square Error = 12.19
[c]Mean Square Error = 12.68

TABLE 2

Effect Sizes for Mean Recall of the Man Sentences for
Younger and Older Children

	Age		
Contrast with Base Sentence Condition	Overall	Younger than Median	At or Above Median
Provided Precise Elaborations	.73	.54	.94
Imagery	1.26	.96	1.65
Elaborative Interrogation	1.71	1.02	2.31

1.88. Imagery recall exceeded base recall, $t(135) = 5.26$.
None of the remaining pairwise comparisons was reliable,
largest $t(135) = 2.24$ for the imagery versus provided
precise elaboration comparison.

The next questions addressed were whether there were
age effects on performance in any of the conditions and
whether there were age by condition interactions. These were
evaluated because of (a) the potential effects of age on the
amount of world knowledge or flexible access to knowledge in
the elaborative interrogation condition (c.f., Bjorklund,
1987) and (b) the possibility of increasing imagery
competence with age in the imagery condition (Pressley,
Cariglia-Bull, Deane, & Schneider, 1987).

The relationships between age and performance for each
condition are recorded as Pearson Product-Moment
correlations (r) in Table 3. The only correlation that was
reliably greater than zero was for the elaborative
interrogation condition. Potential age by condition
interactions were also evaluated using a regression approach
(Cohen & Cohen, 1975). Possible interactions were evaluated
with six contrasts. Simple correlations were first
transformed to Fisher Z. Then condition correlations were
compared pairwise, with each comparison conducted at $p <$
.0083 in order to parallel the analysis of condition main
effects as closely as possible (cutoff $Z = 2.64$). The
correlation between age and performance in the elaborative

TABLE 3

Pearson Product-Moment Coefficients and Z Transformation
Scores for Relationships Between Age and Recall as a
Function of Experimental Condition

Condition	r	Z score
Base Condition	-.118	-.121
Provided Precise Elaborations	-.098	-.100
Imagery	.286	.299
Elaborative Interrogation	.614*	.709

* p < .01

interrogation condition was reliably larger than the
corresponding associations in either the base or provided
precise elaboration conditions, smaller $Z = 3.20$. The next
largest $Z = 1.68$, $p > .08$ for the imagery versus base
comparison.

That there were age by condition interactions stimulated
a breakdown of the recall data as a function of age, with a
median split of the data recorded in Table 1. The median
split data were analyzed using two sets of 6 pairwise Dunn-
Bonferroni contrasts (paralleling the analysis of overall
recall). For subjects below the median age, recall in both
the imagery and elaborative interrogation conditions
exceeded recall in the base condition, smaller $t(61) = 2.87$.
No other pairwise contrasts were significant; next largest
$t(61) = 1.54$, $p > .10$. For subjects at or above the median,
recall in the elaborative interrogation condition exceeded
recall in both the base and provided precise elaboration
conditions, smaller $t(70) = 4.35$. Imagery recall was better
than base recall, $t(70) = 4.81$. The recall in the provided
precise elaboration condition was greater than base recall,
$t(70) = 2.83$. Neither of the remaining pairwise contrasts
was significant, larger $t(70) = 2.17$, $p > .03$.

Question Responses

Childrens' responses to questions in the elaborative
interrogation condition were scored for three types of
answers: precise elaborations, imprecise elaborations, and
failures to produce an answer (no answer). Over 30 percent

of the responses were scored by two raters with 95 percent agreement. Given this high inter-rater reliability, the remaining data were scored by one of the two raters.

Overall, precise elaborations accounted for an average of 7.97 (SD = 3.63) of the answers given. Children's imprecise elaborations accounted for an average of 8.12 (SD = 4.22) of the answers and failure to respond to the questions accounted for an only 1.91 (SD = 2.71) answers. Thus, most of the time, children generated an answer during study, although only slightly less than half of their answers were precise elaborations. More interestingly, the quality of elaborations varied with age. Older children produced more precise elaborations than their younger peers, expressed as Pearson $r(32) = .47$, $p < .003$. There was a corresponding decrease with age in the number of imprecise elaborations, $r(32) = -.41$, $p < .008$. There was no relationship between age and failure to produce an answer, $r(32) = .01$ $p > .40$.

A series of item-by-item conditional probabilities were calculated to determine the relationship between the quality of answer provided during study and subsequent performance at recall. Each response provided at study was matched to the corresponding response at recall. The mean conditional probability (per subject) for correct recall following generation of precise elaborations was 0.83 (SD = .179); following imprecise elaborations was 0.68 (SD = .267); and following non-answered items was 0.76 (SD = .304). Correct

recall following precise elaborations was more frequent than following imprecise elaborations; $t(33) = 3.98$, $p < .001$. However correct recall following failure to generate an elaboration did not differ reliably from generation of either type of elaboration; larger $t(18) = 1.63$, $p > .10$.[1] The conditional probability of correct recall following a precise elaboration was not reliably related to age, $r(32) = .22$, $p > .10$. Thus, the mean conditional probability for subjects below the median age was .80 (SD = .167) versus .85 (SD = .189) for subjects at or above the median --- a small difference (e.g., Cronbach & Snow, 1977). The conditional probabilities of correct recall increased with age for both imprecisely-answered items and non-answered items, $r(32) = .52$, $p < .001$ and $r(32) = .65$ respectively, both p 's < .001. Thus, the mean conditional probability of recall following an imprecise elaboration was = .53 (SD = .167) for subjects below the median age; it was = .79 (SD = .237) for subjects above the median age. The mean conditional probability of correct recall following failure to generate an answer was = .49 (SD =.31) for subjects below the median age, and it was = .92 (SD = .155) for subjects at or above the median age.

<p style="text-align:center">Discussion</p>

Elaborative interrogation produced the largest and most general gains with imagery having more modest effects on

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1 The number of subjects in these analyses varies because some children never failed to generate a response to the "Why" question.

retention. Elaborative interrogation was more potent for
the older compared to the younger children. The finding that
elaborative interrogation was more effective with older
children than provided precise elaborations and no strategy
instruction is consistent with the findings for adults given
the same task (see Pressley et. al., 1987)--- the
performances of older children more nearly approximated the
performances of adults than did the performances of younger
children. The effectiveness of elaborative interrogation
with children is consistent with the work of Bransford,
Stein and associates (1982), and Pressley and associates
(Pressley, McDaniel, et. al., 1987; Pressley, Symons, et.
al., 1988) with adults. Although the recall difference
between elaborative interrogation and no strategy
instruction conditions was large in the present study, the
elaborative interrogation condition for the older children
was comparable in size to the adult findings with an effect
size of 2.3 SD's for older children as opposed to 1.0 SD's
with the younger children. The smallest effect size reported
in previous adult studies was 1.82 SD's (see Pressley,
Symons, et. al., 1988). This finding is also consistent with
the large body of research on higher order questioning which
indicates that learning gains can be enhanced by asking
questions at study that require inferencing, with
larger effects for older children and adults than younger
children (Levin & Pressley, 1981). In fact, with very young
children (preschoolers), the magnitude of the elaborative

questioning effect is probably miniscule, based on data in related questioning research (Wood, Pressley, Turnure, & Walton, 1987). The performance differences between younger and older children in studies to date, including the present one, suggest a developmental trend in the ability to use the different strategies with greater facilitation associated with increasing age.

The imagery strategy was more effective than no strategy instruction, although it was not more effective than provision or generation of precise elaborations. In contrast, with adults imagery quite clearly is more effective than providing precise elaborations (Pressley et. al., 1987). The positive but slightly less impressive effects obtained with imagery compared with elaborative interrogation may be due to imagery being more difficult or demanding for young children than elaborative interrogation. Past research has indicated that there are large individual differences in the ability to use imagery strategies until at least 12 years of age (e.g., Pressley, Cariglia-Bull, Deane, & Schneider, 1987). The present limited effects of imagery may reflect these developmental or individual changes in processing capacity.

It was expected that providing precise elaborations might be effective with children because children generally do not produce elaborations spontaneously, nor do they engage in other sophisticated processing of facts. Previous research documented that provision of precise elaborations

to less academically successful fifth graders produced recall gains. In the present study there was a corresponding significant effect for provision of precise elaborations when compared to no-strategy instruction for the older children in the sample. However, the benefits from provision were considerably lower than those produced by elaborative interrogation, with these differences being especially dramatic for the older children. It may be that providing precise elaborations is particularly advantageous for learners experiencing some difficulty in language or reading comprehension, that is, children like the subjects who benefited from provision of precise elaborations in the Bransford studies (Bransford et. al., 1982). Unfortunately, the effect of ability could not be analyzed in the present study because no measure of general intellectual competence was taken here. A reasonable direction for future research would be study of potential ability by treatment interactions across age.

Nonetheless, the data at hand suggest that the most effective treatment evaluated here was elaborative interrogation. For the most part, children in the elaborative interrogation condition were able to generate an elaboration for almost all of the questions asked of them, although older children generated precise elaborations more easily than their younger peers. The quality of elaboration had a greater influence on recall for younger children than for older children. The performance of the older children

was similar to adults (see Pressley, McDaniel, et. al.,
1987) in that the search for rather than the production of a
precise elaboration predicted greater recall. Younger
children, on the other hand, tended to perform best at
recall if a precise elaboration had been produced rather
than an imprecise elaboration or no answer. It may be that
the generally better developed knowledge base of older
children compared to younger children permits connections to
prior knowledge even if a precise elaboration cannot be
constructed. Direct assessments of the extent of knowledge
base are needed in order to conduct research in which prior
knowledge status is a predictor of successful generation of
precise elaborations and subsequent recall.

CHAPTER 3

EXPERIMENT 2

Elaborative interrogation was a potent strategy for the elementary school children asked to recall the arbitrary relationships specified in the man sentences of Experiment 1. Experiment 2 extended the manipulations examined in Experiment 1 to materials similar to those actually encountered in elementary classrooms. It is rarely the student's task to learn separated, individual pieces of information, especially totally arbitrary facts like the man-action pairings studied in Experiment 1. Given the successes in obtaining positive effects when adults use elaborative interrogation to learn diverse materials, there was optimism that children would benefit from elaborative interrogation of meaningful facts.

In an attempt to approximate a naturalistic learning task for adults, Pressley, Symons, McDaniel and Snyder (1988, Experiment 3) asked Canadian university students to learn facts about Canadian provinces. The facts were presented in individual sentences (e.g., The first schools for deaf children were established in Quebec; Judo was first introduced into British Columbia; and The first university program in forestry was in Ontario). The experiment included reading control (base condition), imagery, and elaborative interrogation conditions. The results mirrored those found in adult "man" studies---elaborative interrogation and imagery subjects remembered more than the reading control

participants, and elaborative interrogation and imagery performances were equal. The elaborative interrogation, imagery and reading control conditions were also compared in another study (Pressley et. al., 1988, Experiment 4) with another set of naturalistic facts. Learning facts about human sex differences (e.g., Men have a slower pulse rate) was greater in the elaborative interrogation and imagery conditions than in the reading control conditions. These studies yielded results similar to those found in earlier investigations with the "man" sentences. The consistent and robust performance gains produced by imagery and elaborative interrogation suggest that these strategies are adaptable to a variety of materials comprised of mutually interfering information.

More common than lists of isolated facts, however, is prose that includes disparate information about one topic. The present study attempted to approximate the demands of this more educationally relevant task with children. The specific concern was children's acquisition of facts from text which would provide additional data on learning of mutually interfering relationships.

Naturalistic prose is rarely completely arbitrary. For this reason the term precise elaboration seemed inappropriate as a descriptor of elaborations that might be generated for prose facts. Instead the term explanatory elaboration describes the type of elaboration provided in some conditions of Experiment 2 and generated in other

conditions. These elaborations are not single "correct" elaborations because in natural prose there is usually more than one possible "correct" elaboration. The prose materials used in Experiment 2 did, however, preserve the structure of the base sentences used in Experiment 1 and in past research (see Pressley et. al., 1987, and Stein et. al., 1982) in that the somewhat novel relationships could be explained using prior knowledge available to the learner. The to-be-learned materials were descriptions of animals and their habits.

In addition, this study permitted another examination of the "quality" of elaboration and its subsequent effect on recall. Unlike past research, the appropriateness of the elaborations was assessed to the extent that the children drew upon correct prior knowledge to answer questions. Since animals engage in specific activities for specific reasons, the explanations for the relationships were more naturalistically constrained than for the man studies. Hence, the responses could be assessed in terms of their actual correctness.

All of the conditions in Experiment 1 are replicated in Experiment 2, and two additional conditions are included: imagery plus explanatory elaboration and no-exposure control. The inclusion of the imagery plus explanatory elaboration condition was prompted by two concerns. Following the dual coding position defined by Paivio (1971), it seemed possible that a combination of imagery and verbal

processing might enhance retention of materials more than verbal or imagery processing alone because information is being coded in two forms. A second argument favouring the combination of imagery and explanatory elaborations follows from the work of Snowman (1985). Snowman advocates combining mnemonic and non-mnemonic techniques to facilitate greater retention. In the present study the explanatory elaboration serves as a non-mnemonic strategy in that it focuses on comprehending relationships among the items to be learned. Imagery instructions, on the other hand, encourage students to form interactive images of the items in order to provide a means (or "route") through which items can be retrieved on a cued recall task. The combination of memorial benefits from the mnemonic imagery strategy and enhanced understanding prompted by explanatory elaboration might be expected to facilitate learning, especially for younger, less efficient learners.

The no-exposure control condition was added to assess prior knowledge that children may possess about the animals described in the experiment. It was expected that the children would have had some exposure to information about animals either through the school or through personal experience. Although the animal stories were designed to tap information that would be novel for most children, the possibility of prior exposure or generalization from existing knowledge about animals could not be eliminated without a control condition in which students responded to

test questions without exposure to the animal stories

(Tuinman, 1974). Thus, no-exposure control subjects from

each age category were asked to complete the recall portion

of the task without hearing the animal stories.

Method

Subjects

The participants were 257 elementary school children

attending one of two public schools in Ontario. The children

were drawn from grades 4, 5, 6, 7 and 8 (age range from 8

years 5 months, to 14 years 0 months). Within each grade,

children were randomly assigned to one of six experimental

conditions: no-exposure control, base, explanatory

elaboration provided, imagery, imagery + explanatory

elaboration provided, and elaborative interrogation (39, 43,

43, 44, 44, and 44 subjects per cell respectively). Males

and females within each grade were distributed approximately

equally across the six cells (total number of males = 108,

and females = 149).

Materials

Three sets of stimulus materials were constructed, each

consisting of 9 stories. Each story described the life and

the habits of one animal in a sequence of six separate

sentences. The stories in one set of materials were composed

of simple declarative statements describing the type of

animal and its specific attributes. These sentences were

underlined. For example, the Grey Seal was introduced by,

"The Grey Seal lives with a group of other Grey Seals." The second set of animal stories contained each of these underlined base sentences followed by a nonunderlined explanatory elaboration that linked the animal and the attribute together as in, "The Grey Seal lives with a group of other Grey Seals in order to drive away large intruders."

The third set of materials contained the underlined base sentences with a "why" question below it. The question asked, "Why does that animal do/have that?" (Alternate wording was used depending on the context.)

Explanatory elaborations were constructed with the assistance of zoologists, game wardens, zoological texts and journals, and a curriculum specialist in English. The completed sentences were presented to five judges who were asked to rate the sentence extensions as explanatory or nonexplanatory. All sentence extensions receiving an explanatory rating from all five judges were selected as story materials for the study. The factual content for all the sentences was determined with the information provided by the zoological references. The style and level of difficulty of the sentences were screened by the curriculum specialist.

All presentations of stories/questions were accompanied by a 22 cm x 25 cm colour picture of the animal (see Appendix D for an example of the corresponding pictures). All stories were also recorded on audio tape, with stories presented in a constant order (Grey Seal, Townsend Mole,

Emperor Penguin, Little Brown Bat, Blue Whale, House Mouse, Swift Fox, Western Spotted Skunk and American Pika).

For each of the 9 animal stories, six statements were constructed. Each statement described one characteristic of that animal. The characteristics were drawn from five categories:

i) Physical Living Environment
ii) Diet
iii) Sleep Habits
iv) Major Source of Predation
v) Preferred Habitat

All nine stories are presented in Appendix E. For example, the life of the Grey Seal was illustrated through the following six sentences (base portion underlined, explanatory elaboration not underlined):

THE GREY SEAL LIVES WITH A GROUP OF OTHER GREY SEALS IN ORDER TO DRIVE AWAY LARGE INTRUDERS.

EACH SEAL WITHIN THE GROUP LIVES ON ONE SPECIAL SPOT OR ROCK ON WHICH IT CAN RAISE ITS FAMILY.

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 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 WHICH IS ONE OF THE BIGGEST MEAT EATERS.

Six general information questions were constructed as a filler task to follow presentation of the animal stories.

Thus, answers to test questions were not from extremely short-term memory since the test was delayed about 2 minutes by these questions:

HOW MANY TIMES HAVE YOU BEEN TO A ZOO?

HOW MANY TIMES HAVE YOU BEEN TO A CIRCUS?

HOW MANY TIMES HAVE YOU BEEN TO AN AQUARIUM?

DO YOU HAVE A LOT OF BOOKS ABOUT ANIMALS AT HOME? YES

NO

DO YOU READ THEM OFTEN? YES NO

HAVE YOU DONE ANY WORK IN CLASS THIS YEAR ABOUT

ANIMALS?

The cued recall test consisted of 54 questions. The test questions provided the type of behavior described for each animal with the child required to recall the appropriate animal (see Appendix F for the recall questions). For example, one recall question for the Grey Seal was, "WHICH ANIMAL EATS FISH THAT ARE FOUND ON THE BOTTOM OF THE SEA". The order of recall questions was random for each child. The items were scored correct or incorrect and, thus, the maximum score was 54.

Three sample sentences were constructed for use during the instructional phase of the study. Each sample sentence described one characteristic of the following animals: Grizzly Bear, Walrus, and Caribou. Appropriate pictures were also provided for these sentences:

BEARS LIKE TO LIVE NEAR THE WATER WHERE THEY CAN CATCH

FISH TO EAT AND SWIM TO COOL OFF IN THE HOT WEATHER.

THE WALRUS EATS CLAMS AND OTHER SHELLED SEA CREATURES.

BECAUSE IT CAN USE ITS LARGE TUSKS TO DIG THE CLAMS OUT

FROM THE BOTTOM OF THE SEA.

BEARS ARE RARE BUT SERIOUS DANGERS FOR THE CARIBOU.

BECAUSE THE BEAR CAN REACH BEYOND THE CARIBOU'S ANTLERS

AND KILL THEM WITH THEIR LARGE CLAWS.

In the base, imagery, and elaborative-interrogation

conditions, only the underlined portion of the three sample

sentences were presented. "Why" questions were placed

directly below the underlined statements in the elaborative-

interrogation condition. The following is an example:

BEARS LIKE TO LIVE NEAR THE WATER WHERE THEY CAN

CATCH FISH TO EAT AND SWIM TO COOL OFF IN THE HOT

WEATHER.

WHY DOES THAT ANIMAL DO THAT?

The completely elaborated sentences (underlined plus

nonunderlined portions) were used for both the explanatory-

elaborations-provided condition and the imagery plus

explanatory-elaborations-provided condition.

Procedure

The procedure was similar to that of Experiment 1. All

children were tested individually in a familiar room in

their school. Children were first trained with the examples

and were provided feedback about their performance. Children

were then presented with the experimental materials with no

feedback provided. After reading/hearing all six stories,

children were asked the six general information (filler)

questions about animals. Then, the 54 recall questions were presented (see Table 4 for a summary of procedures in each of the six conditions).

Similar to experiment 1, all children except those in the no-exposure-control condition were introduced to the task as follows:

Today I'm going to give you some stories about different types of animals. I'll show you a picture of each animal too. Each story will have six sentences in it. Each sentence will tell you something that the animal does; like where the animal lives, or what it eats, or how it sleeps or things that are dangerous for the animal. It's your job to remember the type of animal and the things you hear about the animal in the story. Okay?

Children in the explanatory elaboration-provided and imagery plus explanatory-elaboration-provided conditions were given instructions explaining the elaborations, similar to those used in experiment 1. Children in the explanantory elaboration-provided condition were given the following instructions:

One good way to help you remember the type of animal and the thing it does is to look at the part of the sentence that is not underlined. The part of the sentence that isn't underlined tells you why it is important that the animal would do that type of thing. If you read why it is important that that

TABLE 4

Summary of Procedure and Instructions as a Function of
Condition

Instruction	Condition
Explain Nature of Task	All Conditions
Present 3 Sample Sentences With Pictures a) Train to Reading Instruction	Base, Explanatory Elaboration Provided
b) Train to Create Images	Imagery, Imagery Plus Explanatory Elaboration Provided
c) Train to Answer "Why" Questions	Elaborative Interrogation
Test Memory for 3 Example Questions	All conditions but No-Exposure Control
Present Animal Stories With Pictures	All Conditions but No-Exposure Control
Present List of Animal Names	No-Exposure Control
Ask 6 General Information "filler" Questions	All Conditions but No-Exposure Control
Give 54 Item Recall Test	All Conditions
Debrief on Purpose of Study	All Conditions

animal would do that type of thing it will help you
to remember the sentences.

Children in the imagery plus explanatory-elaboration-
provided condition also received the instructions given to
the children in the imagery condition and hence these
instructions were somewhat more detailed:

A good way to help you to remember the kind of
animal and the thing it does would be to make up a
picture in your head of the type of animal doing
what it says in the sentence. The part of the
sentence that isn't underlined tells you why it is
important that the animal does the things that it is
doing. You should read why it is important for the
animal to do what it does and then make up a picture
in your head. A really good picture will have
everything that is in the sentence. If you can make
up this kind of picture for the whole sentence, it
will help you to remember the sentences.

Similarly, children in the imagery condition were
instructed to create images:

One good way to help you to remember the kind of
animal and the things it does is to make up a
picture in your head of the kind of animal and what
it is doing in each sentence. An especially good
picture to make up would have the type of animal
doing exactly what the sentence says it is doing. If

you can think up this type of picture, it will help

you to remember the sentences.

Children in the elaborative-interrogation condition

received directions about answering the 'why' questions,

similar to those used in experiment 1:

One good way to help you to remember the type of

animal and the things it does in the stories is to

answer the questions. An especially good answer

tells why it is important that only that one type of

animal would do that type of thing. If you can say

why that animal rather than any other animal would

do that type of thing, it will help you to remember

the sentences.

The five experimental groups (all but the no-exposure-

control condition) were provided three sample sentences as

part of the instructions. All children were reminded of

their instructions. The instructions and the feedback

provided during practice were the same as those used in

Experiment 1. Children reading provided elaborations had the

purpose of the elaborations explained after each sentence:

That's a good sentence because it tells you why a

(type of animal) and not any other animal would

(type of behavior).

Children instructed to use imagery were asked to

describe the "pictures in their head" and were given

feedback about the appropriateness of these images.

If the child incorporated all of the information in the
sentence (the type of animal and the behavior),s/he was told
that the image was good and then the sample picture was
presented:

> That's a good picture because it has the type of
>
> animal doing exactly what the sentence says it is
>
> doing. It is like my picture because it has the
>
> animal doing what the sentence says it is doing (the
>
> animal, and the type of behavior).

If a child had difficulty including all of the information,
the child was given one or two prompts (if necessary) to
generate the complete image and then the sample picture was
presented:

> That's a good picture that you have made up but it
>
> doesn't really have (animal or behavior). Can you
>
> think up another picture that has both the animal
>
> and the thing that it is doing? That's a good
>
> picture and it is like my picture because it has the
>
> animal doing what the sentence says it is doing
>
> (animal and behavior).

Children in the elaborative-interrogation condition
were asked to answer the "why" question aloud and were given
feedback on the adequacy of their elaborations. Children's
responses to the three why questions were prompted until
explanatory elaborations were generated (i.e. one that
reduced the arbitrariness of the relationship between the
type of animal and the behavior in which it was engaged). If

the child successfully generated an explanatory elaboration

on their first attempt, they were told that their answer was

an appropriate one:

> That's a good answer because it tells you why it is
>
> important that a (type of animal) rather than any
>
> other animal would (type of behavior).

If the child was unsuccessful at generating an

explanatory elaboration, s/he was told what element was

missing from their answer and were prompted to try again.

Children were given one or two prompts (if necessary):

> That is a good answer but it doesn't really tell
>
> you why a (type of animal) rather than any other
>
> animal would (type of behavior). Can you think of an
>
> answer that would tell us why it is important that a
>
> (type of animal) rather than any other animal would
>
> (type of behavior)?

Immediately following practice with the sentences the

children were given the three practice recall questions:

> WHICH ANIMAL LIKES TO LIVE NEAR THE WATER?
>
> WHICH ANIMAL EATS CLAMS AND OTHER SHELLED SEA
>
> CREATURES?
>
> WHICH ANIMAL HAS BEARS AS RARE BUT SERIOUS DANGERS?

Children were corrected if errors were made in recalling the

animal.

Prior to presenting the nine stories children were

reminded of their instructions. The presentation began by

showing the first animal picture while the child heard and

read the first sentence. After viewing the six sentence cards for one animal, the next animal picture was presented and the next series of statements was heard and read. The children were given 15 seconds between statements to study, respond to questions, or generate images.

After all 54 sentences were presented, children were asked to answer the six general information questions (about prior experiences with animals).

Children were then given the cued recall task (see Appendix F for questions). All questions were asked in a different random order for each child.

Children in the no-exposure-control condition were not exposed to the sample sentences or the animal stories. These children were given a list of the animals typed in capital letters on one 12 cm by 19 cm card in alphabetical order. They were instructed that they would be doing a different task than their classmates:

Today I am interested in finding out what you know about animals. You are going to do something different from the rest of your classmates. Your classmates get to read stories about animals. Then, I ask them questions to see what they remember about the stories. But what I need to know from you is how much people in your grade know about these animals anyway. So I am going to ask you the same questions about the animals that I ask your classmates, but you don't get to read the stories. That way I'll know.

how much you might know about the animals anyway,

okay?. I am now going to show you the names of the 9

animals, and then, I will ask you questions about the

animals. The animals you will be asked about are the

American pika, Blue whale, Emperor penguin, House

mouse, Little brown bat, Grey seal, Townsend's mole,

Swift fox, and Western spotted skunk. It is your job to

tell me which animal you think answers the question.

If you aren't sure, take a guess because it is

really important that you tell me which animal you

think could be the right one, okay?.

<div align="center">Results</div>

As in Experiment 1, the primary analyses were performed

on the recall data with secondary analyses on the responses

provided during study in the elaborative interrogation

condition.

Recall Data

Recall responses were scored as correct only if they

were verbatim matches of the types of animals described

during study.[1] The child had to give the complete animal

label for example "Grey Seal, Western Spotted Skunk etc., or

label the type of animal "seal", "skunk", etc.,. Two raters

judged 20 percent of the recall data with 100 percent

---

1 Because children occasionally produced animal labels that
could not be assigned easily to one of the animals (for
example "weasel" was produced for both fox and pika recall
items), and because some labels that approximated the
correct animal "type" were used for correct and incorrect
contexts (for example coyote was given for "fox" but also
for some "skunk" items), a more liberal scoring scale could
not be applied with certainty in this study.

agreement and the remaining data were scored by one of the two raters.

The recall data are summarized in Table 5 as a function of condition. As in Experiment 1 (see page 28), effect sizes were calculated to compare the magnitude of the differences between the experimental conditions and the base reading condition (see Table 6). Effect sizes ranged between .05 SD's (provided explanatory elaborations and .75 SD's (elaborative interrogation condition).

The mean recall for each of the conditions that were exposed to the stories was greater than mean recall in the no-exposure control condition. For the smallest pairwise comparison (i.e., base versus no-exposure control) $t(250) = 9.34$, $p < .001$. Thus, recall in each of the story-exposed conditions reflects more than just prior knowledge of the animals.

Pairwise differences between the five conditions that were presented the stories were evaluated by a set of 10 Dunn-Bonferroni contrasts (Type I error rate $< .05$ for the set, $p < .005$ per comparison; cutoff $t = 2.82$). Performance in the elaborative interrogation condition reliably exceeded performance in the provided explanatory elaboration condition, $t(212) = 3.25$, and the base condition, $t(212) = 3.49$. None of the remaining pairwise differences were reliable, with the next largest $t(212) = 2.71$, $p < .02$ for the imagery versus base comparison.

TABLE 5

Children's Mean Recall of the Animal Facts Sentences as a
Function of Experimental Condition

Condition	Overall Recall	n
No-Exposure Control		
$\overline{X}$	12.03	39
SD	3.45	
Base Sentences		
$\overline{X}$	26.28	43
SD	6.45	
Provided Explanatory Elaborations		
$\overline{X}$	26.67	43
SD	8.53	
Imagery		
$\overline{X}$	30.55	44
SD	7.93	
Imagery Plus Provided Explanatory Elaborations		
$\overline{X}$	29.93	44
SD	7.06	
Elaborative Interrogation		
$\overline{X}$	31.82	43
SD	6.56	

Mean Square Error = 47.64 for comparisons involving the no-
     exposure control conditions
Mean Square Error = 54.05 for comparisons not involving the
     no-exposure control conditions

TABLE 6

Effect Sizes for Mean Recall of the Animal Facts Sentences

Contrast with Base Sentence	Effect Size
Provided Explanatory Elaboration	.053
Imagery	.581
Imagery Plus Provided Explanatory Elaborations	.497
Elaborative Interrogation	.754

In summary, elaborative interrogation was the only condition to produce detectable gains over performance in the base and provided precise elaboration conditions. The performances in the two conditions involving imagery generation were intermediate between the base and provided precise elaboration conditions on the lower end and the elaborative interrogation condition on the higher end but were not statistically significant from either of these.

Potential age effects within conditions and age by condition interactions were evaluated using regression as in Experiment 1 (see page 31). The correlations between age and performance are recorded in Table 7 as a function of condition. None of these differed from zero at p < .05. No pairwise differences in the size of the age-performance relationships were detected either, largest $Z = 0.56$, p > .25 for the imagery plus provided explanatory elaboration condition versus base condition contrast. Thus, the conclusions followed that the age-related increases in learning were not large enough to reach statistical significance and that the differences between conditions were negligibly different as a function of age.

Question Responses

Children's responses to questions in the elaborative interrogation condition were scored for four types of answers: explanatory elaborations (two types), nonexplanatory elaborations, and failure to respond (no answer or I don't know). The explanatory elaborations were

TABLE 7

Pearson Product-Moment Coefficients and Z Transformation
Scores for Relationships Between Age and Recall as a
Function of Experimental Condition

Condition	r	Z Score
Base Sentences	.142	.141
Provided Explanatory Elaborations	.250	.255
Imagery	.243	.245
Imagery Plus Provided Explanatory Elaborations	.257	.266
Elaborative Interrogation	.238	.234

further scored as correct (i.e. they were logical explanations that were true for the animal), or incorrect (i.e., they were logical explanations but based on information that was not factually correct for that animal) in terms of their congruence with expert knowledge about specific animal behaviors. A correct explanatory answer explained why an animal would engage in the described behavior using information relevant to that type of animal. For example, the response "Because he needs to come up and breathe and if he sleeps in deep water he can't come up and breathe as quickly" was scored as a correct explanatory elaboration for the statement "The grey seal sleeps in shallow water." The response "Because its skin dries out too fast" was scored as an incorrect explanatory elaboration because the information used to explain the relationship was not feasible for the animal under question. Another example of a correct explanatory elaboration, this time for the statement "the little brown bat lives with a few to several hundred other bats", was "To find food, or for protection, or to mate." For the same statement, the response "When they go hunting, like for big things, one bat just couldn't take them on, say like a cow" was scored as an incorrect explanatory elaboration. Over twenty-five percent of the responses were scored by two raters with over ninety-four percent agreement. The remaining data were scored by one of the two raters.

Children provided an average of 36.94 explanatory elaborations (SD = 11.33) to the 54 opportunities; they gave 10.75 (SD = 7.20) non-explanatory elaborations; and they failed to respond 6.32 times (SD = 7.98). Thus, as in Experiment 1, children responded to most questions posed at study; more than three-quarters of the responses provided were explanatory. The number of explanatory elaborations per child increased with age, $r(41) = .44$, $p < .002$; the number of non-explanatory elaborations decreased with age, $r(41) = -.28$, $p < .04$; the number of times that participants failed to answer decreased with age, $r(41) = -.37$, $p < .01$.

A series of conditional probabilities were calculated to determine the relationship between the quality of the explanation provided at study and subsequent recall performance. Similar to Experiment 1, each response to a question was matched to the corresponding response at recall on a per subject basis. The mean probability of correct recall following an explanatory elaboration was .61 (SD = .14); following a non-explanatory elaboration was .57 (SD = .24); and following failure to generate a response was .39 (SD = .35). The generation of any elaboration, either explanatory or non-explanatory, was followed by correct recall more so than was the failure to generate an elaboration, $t(34) = 4.34$, $p < .001$, and $t(34) = 2.96$, $p < .006$ respectively. The difference in conditional probabilities for recall following explanatory and non-

explanatory elaborations was not reliable, t(42) = 1.21, p > .231.

Potential differences with age in these conditional recall probabilities were evaluated by calculating the Pearson r between age and conditional probability for each condition, with r(41) = .16 for explanatory elaborations, r(41) = .08 for non-explanatory elaborations, and r (41) = .05 for non-answered items. Since p > .15 in all cases, it was concluded that conditional probabilities of recall did not vary with age.

In general, the explanatory elaborations tended to be logical and correct. The mean number of correct explanatory elaborations was 32.91 (SD = 10.87) per subject; versus 4.05 incorrect explanatory elaborations (SD = 2.15). The number of correct elaborations increasing with age, r(41) = .46, p < .001, and the number of incorrect elaborations was not correlated with age, r(41) = .007, p > .48.

To determine the effect of "accuracy/correctness" of these elaborations on recall, a series of conditional probabilities were constructed. The mean probability of correct recall following a correct elaboration was .86 (SD = .17) and the mean probability of correct recall following an incorrect elaboration was .14 (SD = .17), a large and significant difference t(42) = 14.15, p < .001. Potential differences by age in the conditional probabilities were evaluated by calculating a Pearson r for each condition, with r(42) = .40 for a correct elaboration and r(42) = -.40

for incorrect elaborations, p < .004 for both cases.
Although there were shifts in the levels of conditional
probabilities with age, recall following a correct
elaboration was better than following an incorrect
elaboration at both age levels, smaller t(17) = 5.41, p <
.001. See Table 8 for a detailed summary of the data as a
function of age.

Discussion

Elaborative interrogation again proved to be an
effective learning strategy with children, especially in
comparison to provision of explanatory elaborations and
reading base sentences. There was a significant advantage
for the use of elaborative interrogation for both younger
and older children. In this study, older children did not
outperform their younger peers, with no age by condition
interactions. Although imagery had enough impact to be
statistically indistinguishable from elaborative
interrogation, it was not demonstrably more effective than
provision of explanatory elaborations or simply reading base
sentences.

It appears that the children were able to create
explanatory elaborations relatively easily for the animal
facts in that the greatest percentage of answers were
explanatory. The quality of generated elaborations differed
across age --- younger children generated less explanatory
elaborations than older children and the number of
nonexplanatory elaborations decreased across age.

TABLE 8

Mean Conditional Probabilities of Correct Recall When
Preceded by Either Correct or Incorrect Explanatory
Elaborations as a Function of Age

Category	Age	
	Younger than Median	At or Above the Median
Correct Elaborations		
$\bar{X}$	.808	.895
SD	.231	.067
Incorrect Elaborations		
$\bar{X}$	.192	.105
SD	.231	.067

Note. Median age = 12 years 0 months.

The probability of correct recall was the same for explanatory versus non-explanatory elaborations, but both of these types of elaborations predicted correct recall more often than the failure to generate an elaboration. No age differences were found for the effect of the quality of elaboration on subsequent recall. Even though there were no age differences in the number of elaborations produced, it appears that the type of elaboration plays a greater role in memory for children than has been found in studies with adults. In previous research with adults (see Pressley, et. al., 1987 for example), the type of elaboration produced at study, or even the failure to produce an elaboration at study, did not predict recall performance. For adults, it appeared that search alone was sufficient to enhance recall performance. The children in the present study approximated the adult pattern with the exception that search had to be accompanied by the production of an elaboration (explanatory or nonexplanatory) in order to enhance performance.

Ratings of the quality of elaborations also indicated that children generated more correct than incorrect elaborations. That is, the rationales offered in response to the why questions tended to be consistent with characteristics of the presented animals while explaining the relationship between the animal and the fact --- in general the answers tended to be factually correct and the children were capable of making the seemingly arbitrary relationships less arbitrary. Older children generated more

correct answers and less incorrect answers than did their younger peers. More important, however, was the finding that recall was much greater following correct rationales than incorrect ones for both age groups. This finding is consistent with previous work (Lipson, 1983; Alvermann, Smith, & Readence, 1985) which demonstrated significant memorial decrements when children were encouraged to use prior knowledge that was obviously inconsistent, or irrelevant for new to-be-learned facts. Although there has been a tendency in the adult literature to de-emphasize concerns about the quality of elaborations since recall did not vary strikingly as a function of elaboration quality (e.g., Pressley, Symons et. al., 1988), quality of elaborations should be attended to with children given the huge difference in probabilities of recall following correct versus incorrect answers.

CHAPTER 4

GENERAL DISCUSSION

The present studies confirm many findings of previous research and extend the study of elaborative interrogation to children. It is particularly important to learn about children's acquisition of facts because they are often required to learn facts in school. Some even believe that failures to learn facts account for many comprehension problems and lack of general competence evidenced even by adult students (Hirsh, 1987; Ravitch & Finn, 1987). Hence, efforts to teach efficient fact-learning strategies are timely.

Among the host of strategies available to enhance associative learning, mnemonic procedures (i.e., ones involving elaborations not necessarily semantically consistent with to-be-learned content) are often contrasted with elaborative strategies that rely exclusively on naturalistic associations and extensions. Using the keyword method, learners can generate interactive images to connect new pieces of information. For example, the vocabulary word carlin means "old woman". To learn this relationship via the keyword method, learners could first isolate an aspect of the word carlin that could be visualized because it refers to a concept already known by them (i.e., this is the keyword). Thus, car would be a good keyword for carlin. Then an interactive image using the keyword and the definition is created, perhaps of an old woman driving a car for carlin.

Even though there are large memorial gains using the keyword method and other mnemonic techniques, they continue to be considered less desirable strategies by some because they involve mediators that are not semantically consistent with the content being learned (Sternberg, 1987). In short, keyword methods are purported by some to be "artificial" methods of learning (see Higbee, 1977 for commentary). One positive feature of elaborative interrogation is that it emphasizes the importance of understanding novel factual information in terms of meaningful information already available to the learner.

Having prior knowledge is one thing, but activating it completely and using it to mediate learning is quite another. This is what elaborative interrogation does. Moreover it does it in a way that makes the strategy compatible with the school environment. Elaborative interrogation is responding to questions, and questions are already routinely experienced by elementary-school children. Such question answering works because children rarely use sophisticated associative strategies on their own (e.g., Pressley, 1982; Rhower, 1973) nor do they always employ their prior knowledge when they could (e.g., Hansen & Pearson, 1983).

The investigations presented here have verified the relative importance of a number of potentially useful instructional procedures. Although these procedures had received attention in studies with adults, the argument that

they could produce learning gains with children was based on speculation prior to this study. The following subsections will outline the efficacy of the instructional procedures based both on previous research and on the two studies reported in this thesis.

Elaborative Interrogation

Consistent with the adult literature, for both the "man" sentences and the more naturalistic animal-learning task, elaborative interrogation consistently facilitated retention for children. Elaborative interrogation was the most potent instructional procedure studied here. Because children exposed to elaborative interrogation instruction recalled more than their peers who only read the sentences, there is evidence that children do not spontaneously elaborate the factual relationship to the degree that they could. That the children's performance is so much greater (ranging in effect size from .75 SD's in Experiment 2 to 2.3 SD's in Experiment 1) when prompted by the "why" question, indicates that children can "think through" the presented relationship but that they probably fail to do so unless explicitly cued. This finding is particularly striking given that children in all conditions were aware of the recall test. Under instructions to prepare for a test, it would be expected that performance in the base reading conditions would be the best that children could do on their own. Yet, base reading participants clearly did not generate spontaneously strategies that would encourage them to think

through the information to the extent of the elaborative

interrogation instruction. Outcomes such as these underscore

the frequent need to support children's learning through

prompts to use more sophisticated and efficient strategies

such as elaborative interrogation.

, In Experiment 1, there appeared to be a developmental

advantage for older children using elaborative

interrogation. However, older children did not outperform

their younger peers in the elaborative interrogation

condition of Experiment 2. Also, the effect size between

elaborative interrogation and the base-reading condition was

smaller in Experiment 2 than in Experiment 1 (lowest effect

size in Experiment 1 was 1.0 SD's for the younger children

and in Experiment 2 the overall effect size was .75 SD's).

Smaller performance differences in Experiment 2 may be an

artifact of the animal facts being linked. Unlike Experiment

1, where each man fact was studied in isolation, related

animal facts were presented in succession. This sequential

presentation may have stimulated more spontaneous

elaboration in the base control group and hence, there would

be less room to compare improvement resulting from

elaborative interrogation instruction. Similarly, younger

children may have benefitted from the presentation of

connected information in that each successive piece of

information may have provided a framework for understanding

relationships contained in subsequent facts. Although the

children were expected to have a conceptual understanding

for the types of animal facts presented, some specific facts were probably less familiar than others. These unfamiliar facts may have been better understood within the context of the other information that was provided and, thus, the task would be somewhat less difficult. Issues such as these suggest the need for more systematic investigation of the interactions between materials and strategy instructions with specific attention to the interactions between knowledge base and strategy instruction.

The effect of the quality of the elaboration produced at study on subsequent recall suggests that the type of elaboration produced by younger children may be more predictive of their later recall than of the recall of older peers or adults. Whereas the older children's findings more nearly matched those found with adults, in that the type of elaboration was a poor predictor of recall, both studies indicated the importance of the type of elaboration generated at study for recall in the younger children. These findings encourage a closer examination of possible developmental differences in learners' search of prior knowledge with particular attention to the relationships between types of elaborations produced and the related search strategies. These concerns seem especially relevant given that greater performance gains were evident when younger children employed correct or relevant information in their elaborations.

Alternative Strategies

Imagery. Although imagery produced reliable effects in Experiment 1, it did not do so in Experiment 2 relative to the base condition. Since the animal facts contained fairly concrete information, it was expected that imagery would enhance learning, especially since past research with comparably-aged children has yielded considerable gains on associative tasks (albeit, simpler ones than the task in Experiment 2) after provision of interactive imagery instructions (Pressley, 1982). It is possible that in Experiment 2, the limited familiarity with the animals under study (as was indicated by the low scores for the no-exposure control subjects) accounted for some problems in producing or retrieving images. For instance, the animals may have been sufficiently unfamiliar to the children that they experienced difficulty creating their images (for example, some children reported some difficulty imagining the size of the American Pika), or more importantly, the provided picture-image may not have been strongly associated to the name of the animal so that memory of the image would not automatically produce the animal name.

That creating images and retrieving names for unfamiliar content can be a problem was confirmed in a study by Pressley and Brewster (in press). Elementary grade school children were either instructed to use imagery or told to do as they wished to memorize facts about Canadian provinces. Half the students in each condition (imagery and control)

were provided stereotyped photographs for each province and trained to pair the picture with the province until they achieved mastery of the province name-picture association (for example, Nova Scotia was represented by a photograph of a coastal fishing village). The other half of the students (nonmastery) were not required to learn the province name-picture linkage although the pictures were available at study. Among control subjects, mastery of the province name-picture associations had no effect on learning new facts about the provinces. In the imagery condition, children who had mastered the picture-province name task outperformed control and non-mastery imagery students in recalling the facts. That is, only when a province name-picture association was previously mastered was it possible to construct an image of a presented fact that, could be retrieved at testing, and mediate recall of the provinces associated with particular facts. At testing reiteration of the presented fact served as a cue for the retrieval of the created image which in turn, was associated with the mastered picture allowing access to the province name. In the imagery nonmastery condition, the cue provided at testing (the fact about a province) probably reinstated the interactive image (the image of the fact within the image of the stereotyped picture) but did not permit retrieval of the province name because the picture-province name association was not mastered. An interactive image is only effective in

promoting recall if retrieval of the image permits retrieval
of verbal labels for concepts represented in images.

A similar situation may have accounted for the more
limited effects for interactive imagery in the present
animal study. The picture representation may not have been
sufficiently associated with the animal name to allow the
children to retrieve the correct animal name at recall even
if they retrieved their image involving the fact and the
depiction of the animal. The implications are clear for
future research involving unfamiliar representations. The
association between the concrete representation of the
object studied and the name of the object should be clearly
established before trying to use an imagery strategy. In
making this argument, it must be noted that there was a very
strong trend in Experiment 2 favouring imagery. Thus,
failure of even 1 or 2 images of animals to elicit the names
of animals would be enough to account for the failure of the
imagery versus base control difference to be statistically
significant in Experiment 2. The possibility that failure to
know animal names even though an image of the animal may be
retrievable should be addressed in future research.

Provision of elaborations. Provision of elaboration
did not consistently enhance recall. Only in Experiment 1
was this strategy more effective than simply studying the
base sentences. Even when imagery and provision were
combined, the retention gains were insufficient to be more
advantageous than providing no strategy instruction at all.

In part the failure to replicate the developmental findings of Experiment 1 in Experiment 2 may again be a function of the materials used in Experiment 2. However, the results of Experiment 2 are consistent with previous research with adults when learning is intentional, in that the marked advantage for provision of elaborations over reading base sentences obtained under incidental learning situations are not maintained in an intentional learning situation. The possibility of developmental advantages for supplying elaborations needs to be examined more closely with specific attention to features of the to-be-learned materials.

In closing, it must be emphasized that the dramatic gains produced by elaborative interrogation do not mean that other elaborative or mnemonic strategies should be abandoned. Elaborative interrogation effects may be limited to fact-learning when the learner has some relevant prior knowledge. When learners have limited knowledge about a topic they are studying, other elaborative strategies may be more appropriate. If the knowledge base were limited but the learner had a strong image on which to peg new information (e.g., a memorized picture of a setting as in Pressley & Brewster, in press), the learner might be better off generating interactive images. If there is virtually no prior knowledge and no concrete peg that could be exploited, neither elaborative interrogation nor interactive imagery would be appropriate learning strategies. Mnemonic techniques, such as the keyword method, might best

facilitate acquisition by promoting the association of the

to-be-learned information. The relative efficacy of the

strategies under various knowledge base constraints should

be examined closely in future research to determine if these

speculations are correct.

Environmental constraints may affect the implementation

of these strategies. Educational and developmental

researchers have demonstrated that variables in the academic

setting (the form of instruction, the impact of teacher and

learner styles and the social context) can also determine

whether a strategy is useful for the acquisition of

information (Snow, 1968; Bronfenbrenner, 1977). None of

these variables were examined here. What was shown was that

with one-on-one instruction children can be encouraged to

search their knowledge base more extensively through

elaborative interrogation, so that learning is increased.

Going beyond studies of one-on-one instruction seems a

reasonable next step in the study of elaboration strategies.

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APPENDIX A

Base and Precisely Elaborated To-Be-Learned Sentences for

Experiment 1.

1. The crippled man flicked the switch.

   The crippled man flicked the switch on his electric

   wheelchair.

2. The religious man used the saw.

   The religious man used the saw to build a church.

3. The Irish man counted the leaves.

   The Irish man counted the leaves on the shamrock.

4. The weak man thanked the checkout girl.

   The weak man thanked the checkout girl who carried his

   groceries for him.

5. The short man bought the broom.

   The short man bought the broom to sweep the crawl space.

6. The bearded man threw out the coupon.

   The bearded man through out the coupon for free razor

   blades.

7. The long-haired man looked for the pole.

   The long-haired man looked for the pole outside the

   barber shop.

8. The evil man wound up the clock.

   The evil man wound up the clock for the time bomb.

9. The kind man ate dinner.

   The kind man ate dinner and offered to help wash the

   dishes.

10. The tall man bought the crackers.

    The tall man bought the crackers that were on the top

    shelf.

11. The blind man hit the flea.

The blind man hit the flea on the seeing-eye dog.

12. The fat man read the sign.

    The fat man read the sign warning about thin ice.

13. The smart man went to work.

    The smart man went to work and made a wise investment.

14. The rich man picked up the chair.

    The rich man picked up the chair and looked at the gold

    legs.

15. The thin man found the scissors.

    The thin man found the scissors and cut the skinny belt

    in half.

16. The sleepy man bought the mug.

    The sleepy man bought the mug filled with coffee.

17. The artistic man put down the knife.

    The artistic man put down the knife after finishing the

    sculpture.

18. The patriotic man memorized the words.

    The patriotic man memorized the words to "O Canada".

APPENDIX B

Sample Line Drawings for the Three Practice Sentences

in Experiment 1.

THE BALD MAN USED THE PHONE.

THE SAD MAN LOOKED AT HIS NEW BOAT.

THE DYING MAN USED A FEATHER.

APPENDIX C

Recall Test for Experiment 1

1. Who flicked the switch?

2. Who used the saw?

3. Who counted the leaves?

4. Who thanked the checkout girl?

5. Who bought the broom?

6. Who threw out the coupon?

7. Who looked for the pole?

8. Who wound up the clock?

9. Who ate dinner?

10. Who bought the crackers?

11. Who hit the flea?

12. Who read the sign?

13. Who went to work?

14. Who picked up the chair?

15. Who found the scissors?

16. Who bought the mug?

17. Who put down the knife?

18. Who memorized the words?

* Items presented in a different random order for each subject.

APPENDIX D

Sample Animal Picture for Experiment 2 (The Grey Seal)

THE GREY SEAL

By courtesy of the British Museum (Natural History)

APPENDIX E

Sample Sentences and Stories for Experiment 2

Sample Sentences·

1) <u>Bears like to live near the water</u> where they can catch fish to eat and swim to cool off in the hot weather.

2) <u>The walrus eats clams and other shelled sea creatures</u> because it can use its' large tusks to dig the clams out from the bottom of the .sea.

3) <u>Bears are rare but serious dangers for the caribou.</u> because the bear can reach beyond the caribou's antlers and kill them with their large claws.

Stories

The Grey Seal

<u>The grey seal lives with a group of other grey seals.</u> in order to drive away large intruders. <u>Each seal within the group lives on one special spot or rock</u> on which it can raise its' family. <u>The grey seal likes to live on the Maritime coast</u> where there are many rocky areas for the seal to consider home. <u>The grey seal eats fish that are found on the bottom of the sea</u> which it can easily dive down to get. <u>The grey seal sleeps in shallow water</u> so that it can come to the surface without having to wake up. <u>The one big danger for the grey seal is the killer whale</u> which is one of the biggest meat eaters.

The Townsend Mole

<u>The townsend mole lives in tunnels</u> where it is safely hidden from other animals that might hurt it. <u>It especially</u>

likes to live in warm, humid areas where the damp soil
sticks together so that the mole's tunnels won't cave in.
Usually the mole prefers the Pacific coast where the soil is
softer for digging. The townsend mole eats insects and grubs
that are found in the ground while the mole is digging. The
townsend mole naps throughout the day when the sunlight is
too bright for its' sensitive eyes. There are few dangers
for the mole except for snakes that can crawl into the
tunnels to eat the mole.

The Emperor Penguin

The emperor penguin lives only in Antarctica where it
is cold enough to have icebergs for penguins to make their
homes on. It likes to live in the sea for a few weeks at a
time where it can store enough food to come out of the water
and live on the ice for a long time. The emperor penguin
never makes a nest or home to hide in because there are no
dangerous animals that live on the ice. The emperor penguin
eats squid and fish but it only eats these for part of the
year when warmer water brings lots of fish for every penguin
to eat. Although Antarctica is cold all of the time, the
emperor penguin sleeps longer when it gets really cold and
then it huddles with other sleeping penguins to save some
body heat. One real danger for the emperor penguin is the
leopard seal because when penguins are really desperate for
food they try to get into the sea by jumping through air
holes in the ice and are caught by seals instead.

The Little Brown Bat

The little brown bat lives in dark places like caves, attics, or abandoned houses. where it is protected from teperatures that are too hot or too cold. The little brown bat lives with a few to several hundred other bats in order to keep warm while it sleeps. The little brown bat lives in eastern Canada where the many streams and forested areas attract the things the bat likes to eat. Its favourite food is flying insects that it can catch while it is flying around. The bat sleeps all winter when there are no insects and it can't fly because its' wings are too cold. There are very few dangers for the little brown bat except for the weather which can kill the bat with temperatures that are too high or too low.

The Blue Whale

The blue whale lives in the Arctic and Antarctic oceans where the water is deep enough for many of these large animals to swim around. Most of the time the blue whale prefers to be near the surface of the water where food is found more easily. The blue whale only eats for about three months of the year because the rest of the time it is busy travelling to the other ocean to find a mate. When it does eat, it likes ocean plants and small shrimp-like creatures which are found in large enough amounts for these big animals. The blue whale sleeps by taking short naps after eating a large meal because it is too full to move. The worst danger for the blue whale is being caught under the ice where they can starve or suffocate.

The House Mouse

The house mouse likes to live in warm, dry areas where there is less disease and sickness. It is most often found anywhere people live where it is certain of finding food. The house mouse lives in southern Canada where there is the largest amount of people. It eats nuts, vegetables, fruits and grains that are commonly found around people's homes. When it is tired, the house mouse heads for its home which is usually a tiny hole or dark corner that is too hard for other animals and people to find. There are many dangers for the house mouse like owls, hawks, and snakes that can gobble it in one bite.

The Swift Fox

The swift fox usually lives all by itself so that it can find enough food near its home to live on. It stays in a ready-made home like a small cave or hollowed out log where it is cool in the summer and warm in the winter. Its favourite place to find a home is near grassy areas that have many small animals to hunt for food and lots of places to hide. When it is hungry, the swift fox eats rabbits, squirrels or mice that are easy to catch because they are so much slower and smaller than the fox. During the daylight hours the swift fox is usually fast asleep because the animals it hunts for don't come out until night time. Coyotes are dangerous for the swift fox because they are bigger and faster and they hunt in groups surrounding the fox so he can't get away.

The Western Spotted Skunk

The western spotted skunk lives in a hole in the ground in order to protect itself and its' family. Often the skunk lives alone, but families of skunks sometimes stay together until the young skunks are old enough and strong enough to look after themselves. The skunk's hole is usually found on a sandy piece of farmland near crops where it is easy to dig a hole to live in and eat what the farmer grows. The skunk mostly eats corn that is found in the farmer's fields around its home. It sleeps just about anytime except between three o'clock in the morning and sunrise when it can look for food without being seen by other animals that might eat it. The biggest danger to this skunk is the great horned owl whose night vision is so good that it can see skunks when they are out in the dark.

The American Pika

The american pika lives so high up in the rocky mountains that trees can't grow and that way the pika can see for long distances in case dangerous animals come too close. The pika likes to live in and around rock piles where its food can be safely stored away under the rocks. The pika is only found in British Columbia where there are many mountains to make a safe home. The pika eats grasses and flowering plants which are some of the few things that can grow high up in the mountains where there is very little soil. The pika sleeps during the night when its' eyesight is too weak to find food or see dangerous animals. The most

<u>dangerous animals for the american pika are birds and</u>

<u>weasels</u> because they can pluck the pika from its rocky

hiding spot.

APPENDIX F

Animal Fact Recall Test for Experiment 2.

1. Which animal lives with a group of others?

2. Which animal lives on one special spot or rock?

3. Which animal lives 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. For which animal is the killer whale one big danger?

7. Which animal lives in tunnels?

8. Which animal especially likes to live in warm humid areas?

9. Which animal usually prefers the Pacific coast?

10. Which animal eats insects and grubs?

11. Which animal naps throughout the day?

12. For which animal are there few dangers except for snakes?

13. Which animal lives only in Antarctica?

14. Which animal likes to live in the sea for a few weeks at a time?

15. Which animal never makes a nest or home to hide in?

16. Which animal eats squid and fish?

17. Which animal sleeps longer when it gets really cold?

18. For which animal is the Leapard seal one real danger?

19. Which animal lives in dark places like caves, attics or abandoned houses?

20. Which animal lives with a few to several hundred others?

21. Which animal lives in Eastern Canada?

22. Which animals favourite food is flying insects?

23. Which animal sleeps all winter?

24. For which animal are there very few dangers except for the weather?

25. Which animal lives in the Arctic and Antarctic oceans?

26. Which animal prefers to be near the surface of the water?

27. Which animal only eats for about three months of the year?

28. Which animal likes to eat ocean plants and small shrimp-like creatures?

29. Which animal sleeps by taking short naps?

30. For which animal is being under the ice the worst danger?

31. Which animal likes to live in warm, dry areas?

32. Which animal is most often found anywhere people live?

33. Which animal lives in Southern Cananda?

34. Which animal eats nuts, vegetables, fruits and grains?

35. Which animal lives in a tiny hole or dark corner?

36. For which animal are there many dangers like owls, hawks, and snakes?

37. Which animal usually lives all by itself?

38. Which animal stays in a ready-made home like a small cave or hollowed out log?

39. Which animals favourite place to find a home is near grassy areas?

40. Which animal eats rabbits, squirrels or mice?

41. Which animal is usually fast asleep during the daylight hours?

42. For which animal are coyotes dangerous?

43. Which animal lives in a hole in the ground?

44. Which aniaml often lives alone but sometimes families stay together?

45. Which animals home is usually found on a sandy piece of farmland near crops?

46. Which animal mostly eats corn?

47. Which animal sleeps just about anytime except between three o'clock in the morning and sunrise?

48. For which animal is the Great Horned Owl the biggest danger?

49. Which animal lives so high up in the rocky mountains that trees can't grow?

50. Which animal likes to live in and around rock piles?

51. Which animal is only found in British Columbia?

52. Which animal eats grasses and flowering plants?

53. Which animal sleeps during the night?

54. For which animal are birds and weasels the most dangerous?

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