The utility of elaborative interrogation for university students studying expository text in preparation for matching and multiple-choice tests.

Vicky Lynn. Martin
University of Windsor

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THE UTILITY OF ELABORATIVE INTERROGATION FOR UNIVERSITY
STUDENTS STUDYING EXPOSITORY TEXT IN PREPARATION
FOR MATCHING AND MULTIPLE-CHOICE TESTS

by

Vicky Lynn Martin

A Dissertation
Submitted to the Faculty of Graduate Studies and Research
Through the Department of Psychology
in Partial Fulfillment of the Requirements for
the Degree of Doctor of Philosophy at the
University of Windsor

Windsor, Ontario, Canada
1994
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ABSTRACT

The purpose of the present research was to investigate the efficacy of elaborative interrogation for the types of tasks university students confront. The utility of the technique was evaluated for university students studying a university-level text on Canadian physiography in preparation for matching and multiple-choice (MC) tests. Three types of processing were contrasted (elaborative interrogation versus imagery versus self-study). Text information was presented in one of two formats (individually-presented facts or text) (i.e., a 3 X 2 factorial design). Hypotheses concerning the pattern of findings were based on consideration of both the processing used by the students and the processing prompted by the passage. It was expected that for both format conditions, elaborative-interrogation and imagery students would outperform the corresponding self-study controls on the matching and factual MC questions. Overall poor performance on the higher-level MC questions was expected for all groups regardless of format. Contrary to expectation, matching performance did not differ for the processing groups for either format condition. A secondary analysis was conducted including only those elaborative-interrogation and imagery students who ranked in the top half of their respective groups in generation of adequate responses. All self-study students were retained. For this supplementary analysis, the pattern of results changed. Students using elaborative interrogation achieved significantly higher matching scores than their corresponding self-study controls, for both format conditions. For this secondary analysis, it was only for the text-format condition that the imagery students outperformed their self-study controls. Think-aloud data indicated that students in
the self-study groups were primarily relying on rote-learning techniques. There was no facilitation of factual MC performance for the elaborative-interrogation or imagery groups relative to the self-study controls. For the higher-level MC questions only the elaborative-interrogation text-format students significantly outperformed their self-study controls (for primary and secondary analysis). Findings were discussed in terms of the types of generative processing prompted by elaborative-interrogation and imagery in contrast to the processing used by the self-study students.
ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

During their university careers, students are faced with increased demands to study expository text, a type of prose which describes and explains non-fictional content. Such text is written using proper vocabulary and provides headings and other signals for the reader to guide them in understanding the structure and theme of the text (Graesser, 1991). Studying expository text is a challenging task as a page of text is dense with ideas (Anderson & Armbruster, 1984). An additional challenge is that exams evaluate not only memory for factual information but also higher-level learning outcomes, such as the students' comprehension of the material and their ability to integrate, apply, and problem solve with the material presented (Thomas & Rohwer, 1986). One factor which is considered important to effective studying is the type of processing in which students engage (e.g., Anderson & Armbruster, 1984; Kardas & Amlund, 1991; Mayer, 1987a). Researchers have stressed that the critical aspect of processing involves students generating their own meaning for the information presented rather than just focusing on the information as presented (Biggs, 1979; Marton & Saljo, 1976a, 1976b; Wittrock, 1974). The purpose of the present study was to assess the utility of elaborative interrogation, a study technique which is intended to prompt students to generate meaning, for university students studying expository text in preparation for matching and multiple-choice tests.

Research concerning the studying of post-secondary students indicates that the majority of students fail to generate meaning but instead rely on rote-learning approaches (Feldt, 1990; Wade, Trathen & Schraw, 1990). Rote learning involves
attending to and acquiring information in verbatim form. Thus the information enters memory without comprehension (Cook & Mayer, 1983). In order to generate meaning from text, students need to engage in "generative processing" (Wittrock, 1974, 1990). Generative processing involves two complementary means of processing text in order to generate meaning and to integrate text content. The first component is the generation of meaning by creating linkages or connections between ideas presented in the text; the second component generates meaning by creating connections between new information and prior knowledge (Wittrock 1974, 1990). Others have also identified the importance of building internal connections among text ideas and external connections between text ideas and prior knowledge (Cook & Mayer, 1983; Mayer 1987a, 1987b).

In an attempt to prompt students to engage in one aspect of generative processing, that is to connect new information with prior knowledge, Pressley and others (Martin & Pressley, 1991; Pressley, McDaniel, Turnure, Wood & Ahmad, 1987; Pressley, Symons, McDaniel, Snyder & Turnure, 1988; Willoughby, Waller, Wood & MacKinnon, 1993; Woloshyn, Willoughby, Wood & Pressley, 1990) have been conducting programmatic research into a study technique known as "elaborative interrogation". Students instructed in use of elaborative-interrogation should eventually be able to use it as a study strategy, that is, they should use it in a controlled and deliberate manner to achieve cognitive goals (Pressley et al., 1990).

Elaborative-interrogation instructions prompt the student to elaborate why a new fact makes sense using information the student already possesses. For example, when presented with the fact, "British Columbia is the province with the largest
percentage of its population in unions", the student would elaborate in response to the question "Why does it make sense that British Columbia is the province with the largest percentage of its population in unions?". If the student knew that British Columbia has large lumbering and shipping industries which employ unionized labour, the student could respond that it makes sense that British Columbia has the largest percentage of its population in unions because most of the population works in lumber or shipping, which are union industries.

Although generative strategies, such as elaborative interrogation, are considered to be an important component in a student’s success in learning from text, they are not the only consideration. Other factors are also expected to place constraints on strategy effectiveness. Such constraints include the type and structure of text with which the strategy is implemented and the criterion task on which the student will be assessed (McDaniel & Einstein, 1989; Thomas & Rohwer, 1986).

While elaborative interrogation has been demonstrated to be highly effective in enhancing university students’ associative memory (i.e., matching and cued-recall tasks) for individually-presented facts, there is no information about the effectiveness of the technique for the kinds of materials and criterion tasks students encounter. One purpose of the present study was to assess the utility of elaborative interrogation for an associative-memory task, a matching task, when students study university-level expository text. Their matching performance on the text material was contrasted to a format used in previous work on elaborative interrogation, that is, the presentation of information as individually-identified facts. No study of elaborative interrogation, to date, has provided data regarding the effectiveness of
the technique when adults study expository text.

A second purpose was to evaluate the effectiveness of elaborative interrogation in enhancing performance on frequently used academic criteria. It is important to investigate the utility of elaborative interrogation for the types of learning criteria used in college and university settings. Since multiple-choice exams are the most popular measure of post-secondary student learning (Aiken, 1987; Linn, 1991), factual and higher-level multiple-choice questions were also used as outcome measures in the present study. Performance on these measures was assessed for both a fact and a text format of the study materials.

A third purpose of the present research was to compare the performance of students instructed in the use of elaborative interrogation to the performance of a control group of students who were allowed to study as they wished (i.e., a self-study control group). The processing of this control group should approximate the processing students actually use when studying. Previous research with elaborative interrogation has used a control group of students who read and reread the information for understanding (Martin & Pressley, 1991; Pressley et al., 1988; Willoughby et al., 1993; Woloshyn et al., 1990). Information about the effectiveness of elaborative interrogation in comparison to a self-study control group would be an important component of any future training effort. One component of a student’s decision to adopt elaborative interrogation as a study strategy would involve information on its effectiveness for enhancement of academic performance in comparison to the student’s usual study methods.

In an effort to understand the type of generative processing prompted by
elaborative-interrogation instructions, the technique's differential effectiveness for
different memory outcomes will be discussed. As research on elaborative
interrogation accumulates there has been a developing understanding of the
mechanism through which the technique enhances certain memory outcomes. Thus,
the initial discussion will be focused on elaborative interrogation and its effect on
laboratory measures of memory (i.e., matching and free-recall tasks). As the
discussion progresses, there will be a gradual expansion in the context in which
elaborative interrogation is viewed. Two contextual factors considered will be type
of text material and criterion task. First, consideration will be given to how text
type and the processing prompted by elaborative interrogation might inter-relate to
influence performance on recognition and recall measures. Conclusions generated
from the discussion for recognition and higher-level learning measures will be
applied to expectations concerning the performance on specific recognition measures,
a matching task and factual multiple-choice questions, and performance on a
measure of higher-level learning, higher-level multiple choice questions.

Summary of Research and Theory Concerning Elaborative Interrogation and Its
Potential for Text

In reviewing the research on elaborative interrogation, it is clear that when
students use the technique, it significantly enhances their performance on
associative-memory measures in comparison to the performance of students who use
a rote approach, that is, reading and rereading factual information for understanding
(Martin & Pressley, 1991; Pressley et al., 1987, 1988; Willoughby et al., 1993;
Woloshyn et al., 1990). In fact, use of elaborative interrogation in comparison to a
reading-to-understand control group has consistently enhanced matching performance and cued recall of the referent by 1 to 2 SD (Pressley et al., 1992). Enhancement of associative memory has held across a variety of study materials, such as arbitrary pairings of actors and actions (Pressley et al., 1987, 1988), facts about Canadian provinces (Martin & Pressley, 1991; Pressley et al., 1988, exp. 3), facts about human gender differences (Pressley et al., 1988, exp. 4), facts about Canadian universities (Woloshyn et al., 1990), and facts about indigenous Canadian animals (Willoughby et al., 1993). This is in keeping with other elaboration research which indicates that elaborative techniques exert their strongest influence on associative memory (Dempster & Rohwer, 1974; Pressley, Levin, Kuiper, Bryant, & Michener, 1982). Thus, the advantage of elaborative techniques is that they enhance memory for the linkage between items, and therefore might be expected to have utility for matching tasks, or cued-recall.

Since the advantage is for associative memory, elaborative techniques would not necessarily be expected to enhance free-recall in which case the pairing has to be retrieved without cuing. In comparison to the enhanced associative-memory outcomes, the data do not support that elaborative interrogation assists in free recall of presented associations. No enhancement of free recall occurred when students used elaborative interrogation to process randomly presented facts about Canadian provinces in comparison to a reading-to-understand control group, composed of students who were instructed to simply read and reread the facts for understanding (Martin & Pressley, 1991). When students were preparing for an upcoming memory test (i.e., intentional learning) of Canadian university facts, free recall was not
enhanced for elaborative-interrogation students in comparison to reading-to-understand control students (Woloshyn et al., 1990). In this same study, it was only when students did not expect an upcoming memory test and the processing of the control group was tightly controlled that use of elaborative interrogation resulted in facilitation of free-recall performance relative to the control group. Taken together, the research results argue that elaborative interrogation exerts its greatest impact on measures of associative learning. The differential effectiveness of the strategy for matching versus free-recall measures is related to the processing prompted by its use.

**Processing prompted by elaborative interrogation.** As presented earlier, elaborative interrogation prompts students to engage in one component of Witrock's (1974, 1990) model of generative processing. That is, students are prompted to generate meaning by creating linkages between new information and prior knowledge. There is converging research support for the hypothesis that elaborative interrogation is a generative processing technique. It's effectiveness is considered to result from the activation of prior knowledge which is consistent with and supportive of the fact or idea as stated (Martin & Pressley, 1991; Willoughby et al., 1993; Woloshyn et al., 1992). To use the generative processing terms of Cook and Mayer (1983), elaborative interrogation prompts "integration" of new information with an existing and related knowledge base. The technique is not intended to prompt students to engage in the complementary aspect of generative processing, that is to generate meaning by the "construction" of linkages (Cook & Mayer, 1983; Mayer, 1987a) between ideas in order to create a coherent structure.
McDaniel & Einstein and their colleagues (Einstein, McDaniel, Bowers, & Stevens, 1984; McDaniel & Einstein, 1989) have introduced yet another term, "proposition-specific" processing, which refers to processing directed to an individual idea and which may be used to refer to generative processing used to create a connection between an individual idea and related prior knowledge. Elaborative techniques are considered primarily to be proposition-specific processing techniques since they focus more on the distinctiveness of the individual idea rather than on the relationships between ideas presented (Hunt & Einstein, 1981). This is the case even though elaboration may sometimes appear to relate or organize ideas presented and thus serve a "relational processing" function (Hunt & Einstein, 1981). Similarly, elaborative interrogation should be considered to primarily prompt proposition-specific processing as it focuses on the meaning of the individual idea by relating it to prior knowledge. The technique does not typically prompt relational processing or construction of information into a coherent whole.

The dependence of elaborative interrogation on proposition-specific processing which involves integration of a new idea with prior knowledge has been demonstrated in elaborative-interrogation research which has manipulated the level of prior knowledge for a particular content area. In one study which manipulated prior knowledge by presenting university students with information about familiar versus unfamiliar Canadian animals, a matching advantage for elaborative interrogation over a reading-to-understand control group occurred only for familiar animal facts (Willoughby et al., 1993). When university students processed facts about unfamiliar Canadian animals, there was no advantage for elaborative-
interrogation. This was the case even though the students were able to provide an explanation of the relationship between the fact and the animal for 65% of their responses. The unfamiliar animal facts seemed to involve a very low knowledge condition as not only were the names of the animals unfamiliar (e.g., "collared peccary", "coati"), but the names did not even suggest a related animal or knowledge which might be useful. By comparison, when students differed in degree of prior knowledge (moderate to high) for facts about Canadian and German provinces, the linkage of new information to prior knowledge through use of elaborative interrogation enhanced matching performance for both groups (Woloshyn et al., 1992). However, the absolute level of matching performance was limited by the level of prior knowledge for the country (Woloshyn et al., 1992).

That elaborative interrogation is effective because it prompts students to understand new facts by connecting them to prior knowledge is supported by data concerning the quality of elaborative-interrogation responses. For example, Martin & Pressley (1991) found that using prior knowledge in a way that supported a new fact was an important determinant of the technique's effectiveness. Quality of elaborative-interrogation responses has usually been rated as adequate, inadequate or a failure to respond (e.g., Pressley et al., 1988; Woloshyn et al., 1990.). Adequate responses clarify why the fact makes sense for the particular referent. Inadequate responses reflect a poor attempt to make the fact sensible, and a rating of no response indicates that the student did not produce a response. A substantial percentage of all elaborative-interrogation responses are classified as adequate (35 to 75 percent). There is usually no significant difference in the probability of a correct
matching response as a function of the quality of elaborative-interrogation response, which has led to the conclusion that the processing prompted by elaborative interrogation results in activation and searching of the knowledge base (Pressley et al., 1992). In a more detailed analysis of adequate responses to facts about Canadian animals, Willoughby found that adequate responses, which were also factually correct, resulted in a significantly higher probability of correct matching than did other adequate responses (Willoughby et al., 1993). The correct elaborative-interrogation responses clearly distinguished the animal for which the fact was true. Thus there may be a particular advantage when students use prior knowledge to increase the distinctiveness of the fact for a particular referent (Willoughby et al., 1993).

As part of the evaluation of elaborative interrogation, the technique has often been compared with imagery, another powerful associative-memory technique (Anderson & Hidde, 1971; Paivio, 1971). Equivalent performance on associative-memory tasks results from use of either elaborative interrogation or imagery (Pressley et al, 1988; Woloshyn et al., 1990), with use of either one significantly enhancing performance in comparison to students in a reading-to-understand control group. As for elaborative interrogation, imagery is also considered to involve the encoding of distinctive or proposition-specific information in a meaningful way (Anderson & Hidde, 1971; Hunt & Marschark, 1987) and assists in the encoding of semantic information (Denis, 1987). Imagery has already been demonstrated to be effective in enhancing learning outcomes for text materials for students who have a facility for generating images (Anderson & Kulhavy, 1972; Denis, 1987). As
research on elaborative interrogation progresses to text material, continued
comparison with imagery would be expected to provide information students may
find valuable in choosing between the techniques, or in deciding which technique
would be most useful for a particular learning task.

In summary, elaborative interrogation is a processing technique which
functions by prompting students to integrate individual facts or ideas with prior
knowledge but it is not intended to prompt students to construct linkages between
ideas. Thus, it would seem to be a proposition-specific rather than a relational-
processing technique. It has been demonstrated to be more effective in enhancing
associative memory than free-recall.

The potential for use of elaborative interrogation with expository text. As
part of the investigation of elaborative interrogation, there has been a gradual
development of materials to be studied from facts to text-like material. Factual
materials have moved from arbitrary actor-action pairings to facts resembling those
students could be asked to study, such as facts about Canadian provinces or
Canadian animals (Martin & Pressley, 1991; Pressley et al., 1988; Willoughby et al.,
1993). The processing materials have also developed from randomly presented facts
(Martin & Pressley, 1991; Pressley et al., 1987, 1988), to facts blocked according to
refferent or topic (Willoughby et al., 1993; Woloshyn et al., 1992), to paragraph-like
presentation of facts (Woloshyn et al., 1990). An argument in favor of elaborative-
interrogation's utility with expository text is that the enhancement of matching and
cued recall has also held across a variety of presentation formats.

Some caution is warranted in arguing for the utility of elaborative
interrogation with text. There are several important differences between the materials used thus far and text materials, such as will be used in the present study. Easily identified differences include that: (1) facts used thus far have presented only one fact-referent pairing per sentence while text would be expected to present more than one pairing per sentence; (2) text materials would be expected to be more lengthy and to present many more facts than have previously been presented for processing using elaborative interrogation; and (3) facts presented thus far have used rather simple sentence structures and vocabulary while university-level text passages would be expected to present more complex syntactic structures and more sophisticated vocabulary. Thus moving from experimenter-created materials to text represents a significant departure from previous elaborative-interrogation research. As Meyer (1977) has noted, text materials are more complex and are less easily controlled by the experimenter. Use of text involves implementation of elaborative interrogation in a whole new context.

Expository text itself has unique characteristics which influence processing and recall of information. Clearly, in developing an argument for the effectiveness of elaborative interrogation with text, text variables need to be considered, especially with regard to possible constraints they may impose on the effectiveness of an instructed processing technique for specific memory and learning measures.

The Influence of Expository Text on the Utility of Elaborative Interrogation for Recognition and Comprehension Measures

McDaniel and Einstein (1989; McDaniel, Einstein, Dunxy & Cobb, 1986) have outlined that one must consider not only the processing the student applies as a
text-processing strategy but also the type of processing prompted or induced by the
text itself. In the same way as student-initiated processing, processing induced by
the text is conceptualized as belonging to one of two categories: "proposition-
specific" processing or "relational" processing (Einstein, McDaniel, Bowers, &
Stevens, 1984; McDaniel & Einstein, 1989). Proposition-specific processing entails
processing which is focused on decoding individual words to comprehend the idea
presented. Such processing deals with individual idea units presented in the text. In
contrast, relational processing involves encoding of relationships and similarities
between items presented in the text, such as determining that items can be
categorized on a similar dimension. Relational processing organizes and integrates
the information presented. Thus, proposition-specific processing should be
considered to involve processing of the item itself without particular regard for how
the item relates to other presented ideas or information; relational processing
involves more focus on how the presented information is linked together, how it
forms a coherent structure or whole.

For several reasons, expository text is considered to prompt primarily
proposition-specific rather than relational processing (McDaniel & Einstein, 1989;
McDaniel et al., 1986). First, relational processing of expository text is difficult for
students as they may lack a well-developed knowledge base for the content area,
which would make it difficult for them to organize or to integrate the information
presented, or to understand how ideas fit together (McDaniel & Einstein, 1989).
Second, students are often unfamiliar with the structure and sequence of presentation
of information in expository text, making relational processing a more difficult task
(Britton, Graesser, Glynn, Hamilton, & Penland, 1983; McDaniel et al., 1986).

Third, the ability to use relational processing may be further impaired as some expository texts are written poorly, requiring the reader to make many inferences to integrate the text (Britton, Van Dusen, Glynn & Hemphill, 1990). Although it may be more difficult for students to follow the sequence of ideas in expository text than in a story or novel, which in turn makes it more difficult for the students to engage in relational processing, it does not necessarily follow that all types of expository text impair relational processing to the same degree. It is therefore necessary to consider the way in which the author has organized ideas or the flow of ideas in an expository text passage.

The work of Meyer (1975, 1981) is useful for further consideration of expository text type. She has identified five expository text structures which differ in the top-level organization or structure of main ideas. A structural analysis of the text (Meyer, 1975; Meyer, Brandt, & Bluth, 1980) reveals the relationship between superordinate ideas and determines the text type.

The five text structures, presenting different relationships between superordinate ideas are: response, description, covariance, comparison, and collection. A response structure presents information in a problem-solution format, such as presenting information about the problem of oil spills from supertankers and problem-based solutions (Meyer, 1977). A description structure presents information about a topic or idea in the style of a journalist by presenting information about who, what, where, when and why (Meyer, 1977). A covariance structure presents a cause-effect relationship (Meyer, 1977) and could be used to explain that the type of
steering in oil supertankers can be related to the occurrence of oil spills (Mayer, 1987b). A comparison top-level structure cues the student that the text will present a comparison of the similarities and differences between two or more main topics. Covariance and comparison texts have very tightly organized structures which clearly signal to students how top-level ideas are related to one another (Meyer, 1977). A collection structure is more loosely organized (Meyer, 1977) and presents a list of ideas or events which are related on some common dimension to form a group. This organizational structure would cue the student to category membership but would not necessarily signal how the ideas or events are interrelated.

Although collection-type text signals some organizational or relational information, its loose structure should make it more difficult for students to process the sequence of, or relationships among, ideas than would be the case for covariance or comparison texts. Therefore, it should prompt relatively more proposition-specific processing than covariance or comparison texts, which more clearly delineate the relationships between ideas. Meyer has reported recall differences between text types favoring covariance or comparison structures over collection structures, with collection-type text being the more difficult of the three types to learn (Meyer, 1977).

That collection-type structures present unique difficulties for students was also recognized and discussed in early research on elaborative interrogation. Pressley (Pressley et al., 1988) suggested that elaborative interrogation should be helpful when students are required to learn from text which presents lists of characteristics of a particular topic or category (i.e., collection-type text). The associations between
the category and the characteristics are arbitrary and thus potentially confusing for
students; they are likely to be processed without understanding because students do
not make use of prior knowledge to make the fact or characteristic sensible (Pressley
et al., 1988). For example, university students are often required to learn
characteristics associated with various political systems, characteristics of different
theories of development, or characteristics of various geological structures (Pressley
et al., 1988). In previous elaborative-interrogation research, characteristics of
Canadian provinces, Canadian animals, or Canadian universities have been presented
for processing and are comparable to a collection-type text structure. Therefore, it is
appropriate to use a text with a collection-type structure when first assessing the
technique’s utility for text. If collection-type text induces or prompts students to
primarily engage in proposition-specific processing, then it is important to look at
the effect of the additional processing resulting from use of elaborative interrogation
on recognition and higher-level learning measures.

In summary, implementation of either elaborative interrogation or imagery
with collection-type text would involve instructing students in the use of a
proposition-specific processing technique with materials which are expected to
primarily induce proposition-specific processing. Let us now consider the impact of
both the study technique and the materials inviting proposition-specific processing
on performance on recognition and higher-level learning outcomes.

The Relationship Between Type of Processing and Performance on Recognition

Versus Higher-Level Learning Tasks.

Recognition tasks. For criterion tasks requiring recognition memory, such as
a matching task, proposition-specific processing is critical as such processing is thought to increase the ability to discriminate individual items (Einstein & Hunt, 1980; Hunt & Einstein, 1981). When a task involves recognition memory, the need to retrieve the information is eliminated and therefore the role of relational information, which assists in retrieval, is minimized (Einstein et al., 1984). The importance of proposition-specific processing to recognition memory is reinforced by the finding that the redundant use of such processing with materials which are already expected to prompt proposition-specific processing enhanced recognition performance in comparison to a group performing a task intended to involve relational processing of the same materials (Hunt & Einstein, 1981).

Therefore, use of elaborative interrogation or imagery with a collection-type text should further enhance recognition performance over the proposition-specific processing induced by the text itself. When considering how the performance of the elaborative interrogation and imagery groups should compare to that of the self-study groups, one must take into account the type of proposition-specific processing used by all three groups. Recognition performance can be differentially affected by the type of proposition-specific processing students bring to the material to be processed (Einstein & Hunt, 1980; Hunt & Einstein, 1981). The additional proposition-specific processing of the elaborative interrogation and imagery groups should be generative in nature, while any additional proposition-specific processing used by the self-study group should involve rote processing. Therefore, recognition performance should be enhanced for the elaborative-interrogation and imagery groups in comparison to the self-study group.
Higher-level learning measures. In contrast to performance on recognition measures, the best performance on comprehension and free-recall measures is considered to result from generative processing which involves both relating information to prior knowledge and creating linkages or connections between information (Cook & Mayer, 1983; Mayer 1987a, 1987b; McDaniel & Einstein, 1989; Wittrock, 1974, 1990). If both components of generative processing are required to enhance comprehension and free-recall performance, use of elaborative interrogation with collection-type text would not be expected to enhance performance on such outcome measures.

Elaborative interrogation focuses only on one component of generative processing, that is, it is only expected to prompt students to connect information stated in the text with prior knowledge. Although students using elaborative interrogation sometimes make use of previously presented information to make sense of a subsequently presented fact (e.g., Willoughby et al., 1993), the technique is not expected to prompt students to engage in the complementary component which is constructing linkages within the text. Neither elaborative interrogation nor collection-type text are expected to prompt the construction of linkages between ideas presented. Therefore, elaborative interrogation would not be expected to enhance performance on criterion measures which assess higher-level learning outcomes to the same extent as it does for recognition measures, in comparison to students who use a rote approach to studying.

As was the case for elaborative interrogation, imagery should also be ineffective in enhancing performance on measures of higher-level learning relative to
a self-study control group. Although use of imagery does allow students to combine factual details into an integrated image (Denis, 1987), the technique is not considered to play a role in the encoding of abstract information such as information shared between sentences, or general principles or themes (Hunt & Marschark, 1987). As previously noted, it is this type of relational processing in combination with generative proposition-specific processing which is considered critical to performance on higher-level questions.

This discussion of the expected differential effect of elaborative interrogation on recognition versus higher-level learning measures has implications for the effectiveness of the technique in enhancing performance on two types of multiple-choice questions. The role of elaborative interrogation in enhancing performance on multiple-choice items will be discussed in the next section.

Implications for Use of Elaborative Interrogation with Collection-Type Text on Factual and Higher-Level Multiple-Choice Questions

As previously argued, in making the progression to expository text materials, it is important to evaluate the potency of elaborative interrogation in enhancing performance on a measure which is commonly used to assess student learning in post-secondary settings. In this case, the measure was multiple-choice (MC) questions. MC exams tend to focus on assessment of recognition of factual information, and there has been a push to include more items which assess higher-level learning, such as the ability to identify a new example of a concept, or to apply a principle in a new situation (Linn, 1991). MC questions can be written and used to assess higher-level comprehension and thinking skills (Linn, 1991; Mehrens &
Factual multiple-choice questions. Performance on both matching items and factual MC questions is considered to require only recognition of fact-referent associations presented in text (Anderson, 1972; Linn, 1991). In terms of Bloom’s (Bloom, Hastings & Madaus, 1971) taxonomy, such items fall within the "knowledge" category as they reflect assessment of memory for factual content and do not necessarily involve higher-level comprehension. Students who take a rote-learning approach, in that they attempt to memorize the information as presented without applying additional generative processing, might be expected to perform well on such items to the extent the tasks measure verbatim retention (Anderson, 1972; Mayer, 1987a). A generative technique (i.e., generating analogies to relate paragraph ideas to prior knowledge) has been found to enhance sentence completion for text facts in comparison to students studying the text using rote processing (i.e., reading and rereading) (Wittrock & Alesandrini, 1990). However, many researchers have failed to obtain an advantage for factual MC test performance for students instructed to use generative strategies, in order to relate higher-level ideas to prior knowledge or to construct an organizational structure for text information, relative to either a self-study or reading-control group (e.g., Brooks, Dansereau, Holley & Spurlin, 1983; Jonassen, 1984; Holley, Dansereau, McDonald, Garland & Collins, 1979). If factual MC questions rely on recognition memory of facts presented in the text, the use of elaborative interrogation, which involves the additional use of a generative, proposition-specific processing technique should enhance performance on these questions in comparison to self-study students. The self-study students should
be concentrating on individual ideas presented in the text and should process these ideas in a rote manner. In the same way, use of imagery should enhance performance on factual MC questions in comparison to the rote processing used by the self-study students.

**Higher-Level Multiple-Choice Questions.** Research comparing student performance on factual versus higher-level MC questions on text content consistently indicates significantly poorer performance on the higher-level questions (Duell, 1978; Feldt, 1990). Higher-level MC questions may be written to assess "comprehension", "application", and "synthesis" abilities as outlined in Bloom's (Bloom, Hastings & Madaus, 1971) taxonomy of educational objectives. Such questions are meant to assess the student's ability to go beyond verbatim information and reflect the student's ability to comprehend and integrate the information presented (Aiken, 1987; Mehrens & Lehmann, 1973).

In order to perform well on higher-level learning questions, Mayer (1987a, 1987b) has argued that students must engage in encoding processes which involve both the building of internal (relating ideas within text to one another) and external (relating ideas within text to prior knowledge) connections. Of greatest importance for application of text content is that the student understand how the pieces of information or ideas interrelate—how they form a coherent structure (i.e., generating connections or links between information presented) (Mayer, 1987b). The structure of the knowledge is important as reasoning with and applying knowledge requires using several pieces of individual knowledge in concert to apply to a new problem (Mayer, 1987b). Student reports of relating ideas within a text passage while
studying (i.e., relational processing) have been associated with better performance on higher-level questions both for a text passage on the concept of criminality (Van Rossum & Schenk, 1984) and for psychology text information (Feldt, 1990).

Since both elaborative interrogation and imagery primarily prompt students to engage in only one aspect of generative processing, that is integrating a new idea or information with prior knowledge, neither technique is expected to enhance performance on higher-level questions in comparison to students using their own, expectedly rote-processing techniques. Although students using elaborative interrogation and imagery should understand the information better than the self-study group, these techniques are not expected to prompt the constructive, generative processing considered necessary to enhance performance on higher-level MC questions written to assess the ability to interpret and extrapolate the studied content material. Therefore, the performance of the elaborative interrogation and imagery students was not expected to differ from that of the self-study students on these higher-level MC questions.

Summary

In summary, elaborative interrogation is a generative technique which prompts students to relate a new idea to prior knowledge (i.e., proposition-specific processing) so that the relationship between the fact and the topic to which it relates is more meaningful and therefore more memorable. Research to date has used either individually-presented facts or facts presented within short paragraphs with one fact-referent pairing per sentence. Clearly, elaborative interrogation exerts its strongest influence on measures of associative memory, especially for recognition of matching
responses. Frequently, elaborative interrogation has been compared with imagery, another powerful associative-memory technique which also prompts generative processing which is proposition-specific. Elaborative interrogation has been demonstrated to be as effective as imagery in enhancement of matching performance. In extending research concerning elaborative interrogation to text material, it is useful to continue the comparison with imagery.

Since collection-type text is most similar in structure to the materials used in previous research on elaborative interrogation, it was reasonable to begin the investigation of utility of elaborative interrogation for expository text with this text type. With collection-type text, use of generative, proposition-specific processing techniques, such as elaborative interrogation and imagery, should result in enhanced matching performance relative to the self-study control group. The advantage for the elaborative interrogation and imagery groups over the self-study group should also hold for factual multiple-choice questions which, like the matching task, are considered to tap recognition memory. However, performance on higher-level multiple-choice questions assesses higher-level learning outcomes which are thought to rely on both types of generative processing—integration of new information with prior knowledge (i.e., proposition-specific processing) and, construction of a coherent structure for the information presented (i.e., relational) processing. Since neither elaborative interrogation nor imagery are expected to prompt both types of generative processing, there should be no enhancement of performance on these higher level MC questions in comparison to the self-study control group.

**Research Design and Hypotheses**

The present study was a 3 (processing instructions) X 2 (format) factorial
design. Three types of processing instructions were contrasted—elaborative interrogation versus imagery versus use of own study techniques (control group). As argued earlier, it was important to include such a control group because elaborative interrogation or imagery will only be adopted by students if these techniques are shown to outperform techniques students currently use. The fact format was included since the present study introduced both a new control group and a new format, that is the text format, to the study of elaborative interrogation. By including the fact-format conditions, the researcher could determine if any failure to replicate a matching advantage for the elaborative-interrogation group versus the control group resulted from the change in format from fact to text or from the comparison with a new control group.

For the matching task, it was expected that for both text and fact formats, the elaborative interrogation and imagery groups would outperform the self-study controls, with no significant difference in the performance of the two former groups. For performance on factual multiple-choice questions, the same pattern of results predicted for the matching task was expected. Overall poor performance on the higher-level questions was expected for all groups.
CHAPTER II

METHOD

Subjects and Design

Criteria for participation and recruitment. Eligibility for participation in the study was based on the student satisfying two criteria. The first criterion required that students had lived in Canada for at least 15 years. This was to ensure that students would have sufficient familiarity with Canada to allow them to produce elaborative-interrogation and imagery responses, that is so that students could comply with their processing instructions. This criterion has been employed in previous research involving elaborative interrogation (Martin & Pressley, 1991). However, level of knowledge for the passage to be studied had to be limited so that students participating did not already know all or most of the information presented. Students who were currently taking or had previously taken a university or college level course in Canadian geography, Canadian history, or Canadian studies were excluded from participation. For these students, there was a great probability that information presented in the critical study passage was already part of their knowledge base rather than being novel information to be learned.

Students were recruited from day and evening sections of introductory psychology courses at the University of Windsor and were contacted during class time. During recruitment, students were informed by the experimenter that the purpose of the research project was to investigate the relationship between students’ approaches to studying and their learning of new information. They were aware that they would participate in a 1.5 hour individual session, which would require them to
study a text passage and to answer multiple-choice and matching questions concerning this same passage. For their participation in the study, students earned experimental credits to be used toward their introductory psychology grade. Those willing to participate signed for an individual session with an experimenter.

Sample characteristics and assignment to conditions. In response to in-class recruitment, 107 students (31 males and 76 females) participated. The mean age of the sample was 21.12 years (SD = 3.35 years, range = 18.17 years to 40.08 years). All students had lived in Canada for at least 15 years and 37% of the sample had taken an OAC level (formerly grade 13) Canadian geography course. Students were randomly assigned (blocked for gender) to one cell of a 3 x 2 factorial design. The first independent variable was processing: elaborative interrogation versus imagery versus self-study (control). The second independent variable was presentation format: fact versus text. Table 1 presents the age and gender characteristics of the resulting six groups and indicates the groups were comparable on these variables.

Materials

Task familiarization passage. The familiarization passage (fact and text formats) was provided to allow the experimenter to introduce and model use of elaborative interrogation or imagery as appropriate and to allow students to practise using their assigned technique with guidance from the researcher. In order to ease transfer of strategy use from the familiarization phase to the study phase, it was important that the passages used for the two phases related to the same content domain, that is, that both passages were from the domain of Canadian studies. Since there has been an increased interest within Canada in the past few years concerning
<table>
<thead>
<tr>
<th>Condition</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaborative-Interrogation/Text</td>
<td>19</td>
<td>21.45</td>
<td>4.58</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Imagery/Text</td>
<td>17</td>
<td>20.22</td>
<td>1.39</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Self Study/Text</td>
<td>18</td>
<td>21.90</td>
<td>4.76</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Elaborative-Interrogation/Fact</td>
<td>19</td>
<td>20.83</td>
<td>3.15</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Imagery/Fact</td>
<td>16</td>
<td>20.61</td>
<td>1.89</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Self Study/Fact</td>
<td>18</td>
<td>21.60</td>
<td>2.70</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>
Canadian native groups, this topic was selected for the familiarization passage.

Much information has been presented in the Canadian media about aboriginal groups
and students would have studied native groups as part of their required schooling.
Thus students were expected to be familiar with the native groups discussed which
should assist them in generating elaborative-interrogation or imagery responses.

Information about the two aboriginal groups was obtained from The Canadian
Encyclopedia (Marsh, 1985). For the text-format condition, the experimenter wrote
a 225-word passage about two Canadian native groups, the Haida and the Iroquois
(see Appendix A). This text passage was written with the same text structure (i.e.,
collection structure; Meyer, 1981) as the critical text passage in order to promote
transfer of the instructed technique to the critical text passage. Some sentences
included more than one fact so that students were forced to identify individual facts
for processing.

For the fact format (227 words), information was presented in the same order,
separated by headings according to native group. Each sentence presented only one
fact about the particular native group (see Appendix B). Both of these passages
were shortened from the version used in the pilot study in order to balance the need
to provide adequate familiarization without undue fatigue.

Critical study passage. A chapter on Canadian physiography (Innes & Heron,
1992) from a first-year university-level text, Profiles of Canada, was selected. The
students in the text condition studied an adapted version of the text chapter. The
chapter was adapted with the permission of the publisher in order to achieve a text
passage which could be studied in a 40-minute time period so that students were not
unduly fatigued during the experimental session. Pilot testing of experimental and control conditions using the text-format condition indicated that the complete passage was too lengthy to meet the study time requirement (see Appendix C). In order to shorten the passage, text concerning two physiographic regions—the Hudson Bay Lowland & Foxe Basin and the Innuitation Region & Arctic Coastal Plain—was removed. In order to reduce the text passage further, some sentences were removed and others were edited. The fact format paralleled the text format except that individual facts were presented as separate sentences grouped according to physiographic region. The text and fact formats of the passage are presented in Appendices D and E respectively.

**Index of general knowledge of Canada.** This measure was included to provide an index of each student’s level of prior knowledge of Canadian geography. For the purposes of the present study, the questionnaire provided a gross but sufficient index of the student’s familiarity with Canadian geography, by requiring students to provide self-ratings of their knowledge of each of the 12 provinces and territories using a 5-point Likert scale. The knowledge level associated with each of the 5 ratings was defined on an accompanying rating key. The rating form used in the present study as well as the rating key for the Likert scale are available in Appendix F.

**Measures**

Three dependent measures were used: performance on matching questions, performance on factual multiple-choice questions, and performance on higher-level multiple-choice questions.
Matching task. Through piloting of facts presented in the critical passage about Canadian physiography, a 40-item matching task was developed. Information about the development of this measure is available in Appendix G. Items selected were considered, as a result of piloting, to represent new learning for the majority of students. Pilot testing indicated which of the potential items could be matched to the appropriate physiographic region without reading the critical passage, that is, on the basis of prior knowledge alone. Items for each of the five physiographic regions were randomly selected from a final pool of items so that representation of each region was proportional to the number of facts presented in the passage for each region. The final matching task is available in Appendix H.

Multiple-choice questions. The multiple-choice test consisted of 20 factual multiple-choice questions and 10 higher-level multiple-choice questions. Factual questions dealt with memory for facts and relational statements presented in the critical study passage. The number of factual questions for each of the five physiographic regions was proportional to the number of facts presented for each region in the text passage. Higher-level questions dealt with the ability to comprehend relationships between facts presented or to extract general principles from the critical passage. Each question had four response alternatives and each alternative was, as much as possible, a plausible response. Appendix I presents information about the development and piloting of the multiple-choice questions. Pilot testing of the experimental and control groups (see Appendix C) indicated that there was sufficient range so that floor and ceiling effects would be avoided. The multiple-choice questions are available in Appendix J, with the correct answer
occurring as alternative (a).

**Procedure**

All students were seen once for an individual, 1.5 hour session with the experimenter in order to complete all experimental tasks. Students were seated at a large desk with the experimenter seated to the side, facing each participant. Due to the length of the session and the demand for the student to speak throughout the session, students were informed they were free to bring coffee or something to drink to the session. Disposable cups for water were also available from the experimenter. Each session consisted of five stages: 1) obtaining consent and collection of demographic information (5 minutes), 2) completion of questionnaire of general knowledge of Canada (5 minutes), 3) familiarization with experimental task (20 minutes), 4) studying critical passage according to instructions (40 minutes), and 5) completion of multiple-choice questions and matching task (20 minutes).

_Consent and collection of background information._ Students read and signed the consent form. The experimenter reviewed the major points covered in the consent, especially the confidential nature of the data collected, the right of the student to refuse to respond to questions, the voluntary nature of student participation, and the right to withdraw at any time during the session without penalty. The first page was the student’s copy, which included a tear-off section for requesting final research results. An envelope was available on the office door if students chose to complete the tear-off section at a later point. The second page of the consent was kept on file. An example of the consent is available in Appendix K.
Eligibility for participation was confirmed by asking the student two screening questions. The first was the number of years the student had lived in Canada. The second was "Are you currently taking or have you taken a university or college level course in Canadian geography, Canadian history, or Canadian studies?" When student eligibility was confirmed, the session continued. Information about the student's age, gender, and whether he/she had taken an OAC-level Canadian geography or history course was also collected.

Completion of questionnaire of general knowledge of Canada. Next, students completed the one-page questionnaire concerning their general knowledge of each of the provinces and territories. The questionnaire required students to rate their level of knowledge of each of the provinces and territories using a 5-point Likert scale.

Familiarization and experimental instructions. In order to provide students with some learning and experience in implementing their particular experimental instructions prior to studying the critical passage, students in all conditions first studied a practice passage. As stated previously, there were two formats (fact or text) for the practice passage, depending on the experimental condition, with both formats presenting the same information about two Canadian native groups—the Haida and the Iroquois. Each of the experimental and control groups received the same general instructions with substitutions appropriate for their condition.

Students in the elaborative-interrogation text-format and fact-format conditions received the following instructions with substitutions for the fact-format condition presented in parentheses:
During this study I will be asking you to study two passages using a particular technique which may be different from the way in which you usually study. The technique you will be using is known as "elaborative interrogation". This involves answering a particular "why" question for each fact you encounter while reading the passage. The why question is "why does that fact make sense for that topic?" Your answer does not need to be the correct or scientific explanation. Rather your answer should make the fact make sense to you or seem reasonable to you given information you already have about the topic. You may want to start your answers with "that makes sense because..." or "that seems right to me because...". First we will go through a practice passage (set of facts) so that I can teach you to use elaborative interrogation and so that you can practice using it on your own. After the practice passage (set of facts), you will go on to the main passage (set of facts). You will not be tested on the practice passage (facts). However, you will be tested on your learning of information presented in the main passage (set of facts) using multiple-choice and matching questions. The first paragraph of this text simply informs you that the passage is about two native peoples, the Haida and the Iroquois. It is not necessary to study a paragraph such as this with your study technique. The first topic presented is the Haida. For each fact, you need to attempt to answer the why question.

Students in the imagery text-format and fact-format conditions received the following instructions with substitutions for the fact-format condition presented in parentheses:

During this study I will be asking you to study two passages using a particular technique which may be different from the way in which you usually study. The technique you will be using is known as "imagery". This involves creating an image or picture in your mind for each fact you encounter. Your picture should combine in one image a picture of the fact and a picture that represents the topic. First we will go through a practice passage (set of facts) so that I can teach you to use imagery and so that you can practise using it on your own. After the practice passage (set of facts), you will go on to the main passage (set of facts). You will not be tested on the practice passage (facts). However, you will be tested on your learning of information presented in this second passage using multiple-choice and matching questions. The first paragraph of this text simply informs you that the passage is about two native peoples, the Haida and the Iroquois. It is not necessary to study a paragraph such as this with your study technique. The first topic presented is the Haida.
Students in the self-study control conditions (text and fact formats) received the following instructions with substitutions for the fact-format condition presented in parentheses:

During this study I will be asking you to study two passages. Paper, pen, and highlighters are available for you, if you wish to use them. You will receive your own copy of each of these passages, so you are free to mark on them if you wish. As you study each passage, read the text aloud and verbalize all your thoughts the moment they occur to you, no matter how trivial they may seem. This is called "thinking-aloud". Since thinking-aloud is probably new to you, we will go through a practice passage so that you can practice verbalizing your thoughts while you study. After the practice passage (facts), you will go on to the main passage (facts). You will not be tested on the practice passage (facts). However, you will be tested on your learning of information presented in the main passage (set of facts), using multiple-choice and matching questions. The practice passage (set of facts) presents information about two native groups—the Haida and the Iroquois. So I would like you to read it aloud as you study and verbalize your thoughts as soon as they occur to you. You may feel self-conscious at first, but I do want you to verbalize what you are thinking no matter how trivial or stupid it may seem to you. You will have 20 minutes to study the passage (facts).

Use of the think-aloud procedure was carefully considered. There are limitations to self-reports which may impact the resulting data on self-study techniques (Ericsson & Simon, 1980; Genest & Turk, 1981). Verbalizing concurrently with a task may impede normal processing and change the thought process and resulting performance. Since the current think-aloud procedure only asks students to report what is currently in their thoughts, that is in short-term memory, and does not bias students in their reporting by suggesting or prompting possible think-aloud responses, it is expected that the verbalization will not affect the outcome of cognitive processing but may slow down the speed of processing (Ericsson & Simon, 1980). Students in the other experimental conditions were also
reporting their processing concurrently with task performance, thus, a slow down in processing might be expected for all groups. A second concern is that students may not give complete reports of thoughts in memory. Thus the data may not completely represent processing that occurred during study, especially processing which is automatic or cannot be easily verbalized. However, the instructions given are meant to minimize interference with processing while providing informative data which are more closely connected with the actual study session than data from self-report inventories or checklists.

For students in the elaboration and imagery conditions, the experimenter provided direct instruction, modelling of appropriate elaborative-interrogation or imagery responses, and feedback for student-generated responses. For the first fact, the experimenter provided students in the elaboration and imagery conditions with a sample response. For the next three facts, the students in these conditions generated their own responses. They received feedback from the experimenter on the quality of their response, along with another sample response for the same fact. This was to reinforce to students that there was not just one correct response. For the remaining practice facts, students continued on their own, producing their responses aloud and receiving specific feedback from the experimenter. The text-format groups received additional instruction and feedback in identifying individual facts. Table 2 presents type of feedback and a sample response for each of the elaboration and imagery conditions.

For the self-study control conditions, students studied the passage as they wished, however during the familiarization time they practised using the think-aloud
Table 2

**Feedback and Sample Answer Given for a Sample Familiarization Fact as a Function of Experimental Condition**

<table>
<thead>
<tr>
<th>Experimental condition</th>
<th>Type of feedback and sample answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaborative</td>
<td>That's a good answer and/or try to make your answer...My answer might have been that eagles and ravens are birds found along the B.C. coast and native spirituality is often tied to nature, so it would make sense that the Haida would name their clans after birds found in the area.</td>
</tr>
<tr>
<td>Interrogation</td>
<td>That's a distinctive and clear image and/or try to make your image....My image might have been two Haida men, one with a raven on a headdress and one with an eagle headdress. I know they are Haida natives because they are wearing their blue jeans and flannel shirts.</td>
</tr>
</tbody>
</table>
procedure. If there were long silent pauses during the familiarization session, the experimenter prompted the student by asking "what are you thinking?".

**Study of critical text/fact passage.** Instructions for the study phase began with an introduction to the five physiographic regions presented in the study passage. This was to ensure that all students were aware of the general location of each of the regions. Instructions were as follows:

Now you are ready to go on to the main passage which is about different physiographic regions of Canada--regions which share a common physical geography. In order to familiarize you with the regions, I will now show them to you on this map which I'll let you study for one minute [begin timing]. First, here is the Canadian Shield, this is the Great Lakes St. Lawrence lowland, out in the Maritimes is the Appalachian region, the Prairies are the Interior Plains, and here is the Western Cordillera. Continue to familiarize yourself with the regions. [timing continued until end of 1 minute]

Next students were given specific instructions about the study period and reminded of the processing instructions for their condition. Students then proceeded to study as instructed and each study session was recorded using a Bell and Howell tape recorder. If students finished early, they were asked to continue studying as instructed for the remaining time. The duration of each student’s study session was timed in minutes and recorded (elaborative interrogation text format $M = 39.05, SD = 2.55$; elaborative interrogation fact format $M = 40.00, SD = .67$; imagery text format $M = 39.05, SD = 2.25$; imagery fact format $M = 39.88, SD = 1.05$; self-study text format $M = 39.5, SD = 1.47$; self-study fact format $M = 39.72, SD = 1.18$).

Students in the elaborative-interrogation text-format condition were given the following instructions with alternate instructions for the fact-format condition presented in parentheses:
You will have 40 minutes to study the 5-page passage (5 pages of facts) by answering the why question for each of the facts presented, just like you did during practice. That will be enough time to get through the passage. You don’t have to rush but you don’t want to get stuck on any one fact. I will let you know when there are 20 minutes and 10 minutes left. In your answer, you want to make the relationship between the fact and the region for which it is true seem sensible for you, i.e., why does it make sense that the fact is true for the specific region. Again your answer does not have to be the correct or scientific answer. In your response, you need to make some reference to the fact to which you are responding just as you practised. There are two terms you will be reading that I am defining for everyone. The first is "relief" which means the height or altitude of the land. The second term, "topography" means the surface features of the land, the look of the land surface when viewed from above. Since your responding will be tape-recorded, you need to speak loudly and clearly. Do you have any questions or are you ready to go ahead?

Students in the imagery text-format condition were given the following instructions with alternate instructions for the fact-format condition presented in parentheses:

You will have 40 minutes to study the 5-page passage (5 pages of facts) by creating an image for each fact and then describing your image aloud, just like you did during practice. That will be enough time to get through the passage. You don’t have to rush but you don’t want to get stuck on any one fact. I will let you know when there are 20 minutes and 10 minutes left. In your answer, you want to generate a clear, distinctive image for the fact which connects it to its region. It is important that your image makes clear to which fact you are responding. It is important that you attempt to generate and describe an image for each fact. There are two terms you will be reading that I am defining for everyone. The first is "relief" which means the height or altitude of the land. The second term, "topography" means the surface features of the land, the look of the land surface when viewed from above. Since your responding will be tape-recorded, you need to speak loudly and clearly. Do you have any questions or are you ready to go ahead?

Students in the self-study text-format condition were given the following instructions with alternate instructions for the fact-format condition presented in parentheses:
You will have 40 minutes to study the 5-page passage (5 pages of facts). That will be enough time to get through the passage. You don’t have to rush. I will let you know when there are 20 minutes and 10 minutes left. As you study, you need to read the passage aloud and verbalize all your thoughts the moment they occur to you, no matter how trivial they may seem. There are two terms you will be reading that I am defining for everyone. The first is "relief" which means the height or altitude of the land. The second term, "topography" means the surface features of the land, the look of the land surface when viewed from above. Since your responding will be tape-recorded, you need to speak loudly and clearly. Do you have any questions or are you ready to go ahead?

Although voice level was checked at the end of the familiarization phase, study protocols of 4 students (2 elaborative interrogation-text, 1 elaborative-interrogation-fact, and 1 self-study text) were lost due to equipment failure.

**Testing.**

**Interference task.** Prior to administration of the multiple-choice and matching questions, students completed a distracter task. Instructions were as follows: "Now I need you to count backwards from 100 by 7’s as quickly as you can until I tell you to stop. Go ahead. [time 1 minute]. Stop."

**Multiple-choice questions.** Next, students completed the multiple-choice questions. Students were randomly assigned 1 of 4 random orders of the 30 multiple-choice questions (blocked within condition). Instructions were as follows:

Here are the multiple-choice questions about the passage you just studied. Please read each question and the four response alternatives carefully. Then select and circle the alternative you consider to be the best response. You will have 15 minutes and this should be sufficient time to complete the questions. When answering you may find it helpful to think of your (answers to the why-question/images/studying). If you don’t know which alternative is the best response, simply make your best guess so that you answer each question.

**Matching task.** After completion of the multiple-choice questions, students
completed the matching task. Within each condition, students were randomly assigned to 1 of 4 random orders of the 40 matching items. The student matched each fact with the region for which it was true using a list of the five physiographic regions. If the student thought the fact was true for more than one region, they could offer a second matching response. Instructions for the matching task were as follows:

Here are some of the facts that appeared in the study passage, but they are in a scrambled order. I would like you to match each of the facts with the region for which it is true. The names of the 5 regions are on the sheet in front of you. If you consider a fact to be true of more than one region, you may provide a second matching response. It is important that you provide an answer for each fact. Again, you may want to think of your [answers to the why-question/images/studying] to help you with your matching. If you can’t recall the correct region, simply make your best guess.

**Rating of Elaborative-Interrogation and Imagery Responses**

**Quality of elaborative-interrogation responses.** For all elaborative-interrogation subjects, elaborative-interrogation responses were rated for quality. Responses were rated as belonging to one of five categories. An "adequate" elaborative-interrogation response clearly linked the fact to the region for which it was true using something the student seemed to already know about the region. If a student generated some sort of explanation but the explanation did not fit the criteria for an adequate response, it was rated as "inadequate". An inadequate response could result from failure to link the fact with the region, or from use of information presented in a preceding fact rather than knowledge the student already possessed. A response was rated as "other" if the student did not comply with processing instructions, that is, the student used imagery or a mnemonic rather than elaborative-
interrogation. An item was scored as "no response" if the student did not respond to an item or simply restated the item. Finally, some students were not able to finish the entire passage in the time allotted and the researcher requested that they simply read the rest of the passage in order to finish. Such items were rated as "not attempted".

Thirty percent of the protocols for the elaborative-interrogation conditions were rated independently by two raters. For the text-format condition, interrater reliability as measured by percent agreement was 83.5 percent. Cohen's kappa (Howell, 1992) was .73. For the fact-format condition, interrater reliability was 89.7 percent. Cohen's kappa was .79.

Quality of imagery responses. For all imagery subjects, study answers were rated for quality of response. Responses were rated as belonging to one of five categories. An "adequate" image clearly linked a picture representing the fact with an image representing the region for which the fact was true. An imagery response was judged to be "inadequate" when it represented only the fact or the region, when it did not link the pictures into one image, or when the image did not clearly represent either the fact or the region. When students used a technique or mnemonic rather than imagery, the response was scored as "other". An item was categorized as "no response" when the student did not respond or simply restated the fact. Finally, some students were unable to finish processing the passage in the allotted time and were asked to read the remainder to finish. As a result, some items were simply read and these were scored as "not attempted".

Thirty percent of the protocols for the imagery conditions were rated
independently by two raters. For the text-format condition, interrater reliability as measured by percent agreement was 97.5 percent. Cohen's kappa was .76. For the fact-format condition, interrater reliability was 95.5 percent. Cohen's kappa was .93.

Rating of Think-Aloud Protocols and Study Notes of Self-Study Groups

All of the think-aloud protocols and notes generated by self-study students were rated using a system developed by Wade et al. (1990). The system was adapted slightly for the purposes of the present research. Ratings were made of two of the main categories of study tactics: mental-learning tactics and text-noting tactics.

Mental-learning tactics were used to rate the type of processing utilized by the student. Responses were categorized in 1 of 5 categories of mental-learning tactic, which included: rote learning, elaboration, imaging, mental integration and self-questioning. When students attended only to verbatim information, their processing was rated as "rote learning". Such rote-learning activities included reading aloud or reciting information presented. Paraphrases involving changes in only a few words from the passage wording were also rated as rote processing. For the purpose of the present study, one of the learning tactics was renamed "elaboration". Items rated as elaborations involved the student mentioning some prior knowledge which related to the fact being processed. For example, when reading a fact on sedimentary rock, a student might comment that he/she remembered studying sedimentary rocks in high school and that sedimentary rocks are layers of rock. Responses in which the student described a picture or image relating to the fact were scored as "imaging" responses. Processing was scored as "mental integration" when, after reading a
section of the passage, a student stopped to summarize or to sort out how ideas fit together into a whole. Finally, if a student asked and answered a question concerning the passage content, the response was rated as "self-questioning".

The text-noting tactics allowed rating of markings and notes produced by students and these tactics include: highlighting, verbatim copying, paraphrased notes, outlining and diagramming. Of these only the last two tactics seem in need of definition. Use of the outlining tactic involved noting a hierarchical relationship between items, while rating a notation as diagramming would indicate that the student generated a spatial representation of the information, which could include a chart or diagram.

Two raters independently rated the combined results of the think-aloud protocols and study notes (30 percent of the data). For each of the facts presented in the passage, any mental-learning tactic(s) used was rated. Since a student may have processed a fact more than once, more than one mental-learning tactic rating could be assigned for any one fact. If the subject generated notes or highlighted the passage, a rating of the text-noting tactic was made and assigned to the corresponding fact. Cohen's kappas for interrater agreement for students in the self-study fact-format and self-study text-format conditions were both .96.
CHAPTER III

RESULTS

Prior to presentation of the results for the matching and multiple-choice questions, the study techniques used by students in the self-study groups will be presented and the degree of compliance of the experimental groups with their processing instructions will be addressed. First, since the self-study students were allowed to study as they wished, understanding the processing these students used during study is important to understanding later comparisons with the experimental groups on the outcome measures. Second, it is important to understand the criteria by which compliance was defined and the degree to which the experimental groups complied with their processing instructions.

Study Techniques of the Self-Study Controls

As was presented in the method section, the think-aloud protocols and notes generated by the self-study students were rated using a system developed by Wade et al. (1990). This system uses the term "tactic" to refer to individual study techniques which are not necessarily used as strategies. Thus when describing the study techniques using the Wade et al. (1990) system, the term tactic will be used. For each self-study subject for each fact, any mental-learning tactic(s) and text-noting tactic(s) applied to the fact during study were rated. If both rote learning and another mental-learning tactic were applied to the same fact, the rote-learning score was ignored in rating the item. After rating each fact, the percentage of items falling within each of the mental-learning and text-noting categories was calculated for each subject. If more than one mental-learning tactic, excluding rote learning,
was used in studying a particular fact, each was counted separately in calculating percentage use. For the rote-learning category, only items for which rote learning and no other mental-learning tactic was used were included in the percentage for the category. If more than one text-noting tactic was used for studying a particular item, each tactic was included in the percentage counts for its particular category.

**Fact-format condition.** The mental-learning tactics used by the most students were rote learning and elaboration. All students were rated as using some rote learning as well as some elaboration. Imagery and mental integration were implemented by fewer students, while self-questioning was used by the least number of students. Table 3 presents descriptive information about the frequency of use (percentage of students and percentage of items) of each of the mental-learning and text-noting tactics rated from the think-aloud protocols and notes of these self-study students.

When evaluating the percentage of items for which each student applied a particular type of processing, it was evident that a preponderance of the facts presented for study were processed using rote-learning tactics. The other mental-learning tactics, elaboration, imagery, mental integration and self-questioning, were used with only a small percentage of the facts presented. Elaborations were poor in quality and often involved recall of irrelevant information such as that a friend or a family vacation was associated with the region. However, two students used elaboration for a substantial percentage of the facts (31% and 58% of the facts). The elaborations of these students used prior knowledge to attempt to make sense of the facts being studied. Unlike the other students, these two students did not rely on
Table 3

Summary of the Mental-Learning and Text-Noting Tactics Used by the Self-Study

<table>
<thead>
<tr>
<th>Fact-Format Group</th>
<th>Study Tactics</th>
<th>% of students using tactic</th>
<th>% of items for which tactic used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental-Learning Tactic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rote Processing</td>
<td>100</td>
<td>84.4</td>
<td>41- 99</td>
</tr>
<tr>
<td>Elaboration</td>
<td>100</td>
<td>12.4</td>
<td>1- 58</td>
</tr>
<tr>
<td>Imaging</td>
<td>59</td>
<td>2.4</td>
<td>0- 11</td>
</tr>
<tr>
<td>Mental Integration</td>
<td>53</td>
<td>1.2</td>
<td>0- 6</td>
</tr>
<tr>
<td>Self-Questioning</td>
<td>24</td>
<td>0.4</td>
<td>0- 3</td>
</tr>
<tr>
<td>Text-Noting Tactic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highlighting</td>
<td>65</td>
<td>34.1</td>
<td>0-100</td>
</tr>
<tr>
<td>Verbatim Notes</td>
<td>1</td>
<td>25.1</td>
<td>0- 98</td>
</tr>
<tr>
<td>Paraphrase Notes</td>
<td>18</td>
<td>1.1</td>
<td>0- 13</td>
</tr>
<tr>
<td>Outlining</td>
<td>29</td>
<td>2.1</td>
<td>0- 15</td>
</tr>
<tr>
<td>Diagramming</td>
<td>24</td>
<td>0.7</td>
<td>0- 7</td>
</tr>
</tbody>
</table>

1. Mental-learning tactic and text-noting tactic categories were developed by Wade et al. (1990).

Note. N=17. Percentages do not add to 100% because the same student may use more than one tactic and more than one tactic may be applied to any one fact.
rote-learning tactics. Mental integration was used primarily to summarize the three levels of increasing elevation in the Interior Plains region or to pull together the three regions which comprise the Western Cordillera. These sections of text seemed poorly written and did not provide clear signals for students as to the three levels or the three regions. Self-questions, when used, dealt with asking and answering questions about factual content.

For the most part, students relied on two text-noting tactics, highlighting and/or taking verbatim notes. These were the text-noting tactics used by the most students for the greatest percentage of facts. Paraphrase notes were essentially verbatim notes with one- or two-word substitutions. The small percentage of students who wrote hierarchically organized notes or drew a diagram used these tactics for only a small percentage of facts.

When looking at similarities among and differences between individual students in their use of mental-learning tactics, three different groups could be identified. The first group, 41 percent of the students, relied almost exclusively on rote-learning and text-noting tactics which evidenced reliance on the passage as written (i.e., rote processing). These students read and reread the material in combination with highlighting and/or writing verbatim notes, making little attempt at elaboration or imaging. A second group, comprising 47 percent of the students, read and reread and highlighted the passage but additionally engaged in limited use of elaboration and/or imaging tactics. Of this second group, 26 percent, or 29 percent of the entire self-study fact-format group, supplemented use of rote-learning, and limited use of elaboration and imaging with minimal attempts at mental integration.
A third group, comprising two students, used rote-learning tactics for approximately half of the facts and made substantial use of elaboration for the remaining facts. These two students were clearly not relying on rote processing.

**Text-format condition.** For self-study students in the text-format condition, a summary of the percentage of students using each mental-learning and text-noting tactic, as well as the percentage of facts for which each tactic was used is available in Table 4. The most frequently used mental-learning tactic was rote learning. All students were rated as using rote-learning tactics. Elaboration was also used by the majority of the students. These elaborations often referred to irrelevant prior knowledge such as a friend who lived in the region. Almost half of the students mentally integrated information by stopping to summarize. As in the fact group, mental integration tended to occur in order to comprehend the levels of the Interior Plains or the regions of the Western Cordillera. Imagery and self-questioning were used by only a few students and for very few facts.

Text-noting tactics most frequently used were highlighting and the taking of verbatim notes. A much smaller percentage of students used either outlining, diagramming, or writing of paraphrased notes. Most facts were noted by use of either highlighting or taking verbatim notes. Only small percentages of facts were noted in paraphrased notes, or hierarchically organized or diagrammed notes. One student constructed elaborate diagrammed notes by constructing a table of the five physiographic regions.

In comparing the similarities among and differences between students in the mental-learning tactics used, two groups were clearly identifiable. One group used
Table 4

Summary of the Mental-Learning and Text-Noting Tactics Used by the Self-Study

Text-Format Group¹

<table>
<thead>
<tr>
<th>Study Tactics</th>
<th>% of students using tactic</th>
<th>% of items for which tactic used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Mental-Learning Tactic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rote Processing</td>
<td>100</td>
<td>96.2</td>
</tr>
<tr>
<td>Elaboration</td>
<td>60</td>
<td>3.6</td>
</tr>
<tr>
<td>Imaging</td>
<td>12</td>
<td>0.2</td>
</tr>
<tr>
<td>Mental Integration</td>
<td>47</td>
<td>1.4</td>
</tr>
<tr>
<td>Self-Questioning</td>
<td>35</td>
<td>1.2</td>
</tr>
<tr>
<td>Text-Noting Tactic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highlighting</td>
<td>70</td>
<td>38.5</td>
</tr>
<tr>
<td>Verbatim Notes</td>
<td>70</td>
<td>29.0</td>
</tr>
<tr>
<td>Paraphrase Notes</td>
<td>29</td>
<td>0.6</td>
</tr>
<tr>
<td>Outlining</td>
<td>35</td>
<td>2.3</td>
</tr>
<tr>
<td>Diagramming</td>
<td>24</td>
<td>3.9</td>
</tr>
</tbody>
</table>

¹. Mental-learning tactic and text-noting tactic categories were developed by Wade et al.(1990).

Note. N=17. Percentages do not add to 100% because the same student may use more than one tactic and more than one tactic may be applied to any one fact.
only rote-learning tactics in processing the passage and this group comprised almost half of the students (47 percent). Half of the students in this first group were organized or planful in their use of rote learning. Rather than simply reading and rereading information, they narrowed the amount of information to which they attended. That is, they highlighted or took notes on a subset of information and then applied rote-learning tactics to their notes or highlighted segments of text, rather than returning to reread all the information presented. The second group, which comprised the other half of the students (53 percent), showed some limited use of generative processing in generating elaborations or images, in self-questioning about content, or in mentally integrating information. However, even in this group rote-learning techniques predominated and were applied to the vast majority of facts.

Though the majority of self-study fact-format students and self-study text-format students used rote-learning for the majority of the facts presented, there was a wider range in the percentage of facts for which rote-learning was applied in the fact-format condition versus the text-format condition. In order to determine if the two format groups differed in their tendency to use rote-learning techniques, the percentage of facts studied using rote-learning techniques was contrasted using Wilcoxon’s Rank Sum Test (Howell, 1992). This nonparametric test was used as both sets of scores were negatively skewed. The results of the Wilcoxon test indicated that there was a significantly greater tendency for the self-study text-format students than the self-study fact-format students to use rote-learning tactics, \( W_{17} \) (17, 17) = 268, \( p < .05 \). Therefore, if the fact-format students were less limited to using rote-learning tactics than the text-format students, the self-study fact-format group
could be considered to be a more stringent control group than the self-study text-format group for their respective experimental groups.

**Compliance of Experimental Subjects with Processing Instructions**

Information regarding the quality of elaborative-interrogation and imagery responses was examined to evaluate the degree of subject compliance with processing instructions for these conditions. A reasonable criterion for compliance was considered to be the generation of responses consistent with instructions for at least two-thirds of the items presented for processing.

**Elaborative-interrogation students.** Across the fact and text formats, rates of compliance with elaborative-interrogation instructions were fairly high. That is, 80 percent of the students, for whom study protocols were available, were rated as meeting the criteria for compliance with processing instructions. These students generated elaborative-interrogation responses (either adequate or inadequate) for 66 to 97 percent of the items. Adequate elaborative-interrogation responses were generated for 15 percent of all facts presented for processing across all subjects complying with processing.

Adequate responses made clear why the fact was true for the physiographic region stated, using information the student already knew. Thus, an adequate response for the fact that The Canadian Shield covers about 40 percent of Canada could be "it takes up most of Canada’s area, it runs from Alaska down on through Hudson Bay along into as far as Quebec". Inadequate responses either did not link the fact with the region, or clearly reflected use of information recently presented in the passage rather than use of the student’s own knowledge. An example of an
inadequate response for the Canadian Shield fact. The local relief is generally less than 100 metres, would be "it makes sense that the local relief is less than 100 metres because the mountains have eroded away". This explanation makes use of the immediately preceding fact. Thus, both adequate and inadequate elaborative-interrogation responses indicated that students were complying with elaborative-interrogation instructions rather than using a self-selected study technique.

For the elaborative-interrogation fact-format condition, the data of one student were excluded due to inadequate compliance with processing instructions (i.e., generating adequate or inadequate responses for only 53% of the facts). For the elaborative-interrogation text-format condition, the data of six students were excluded due to inadequate compliance (i.e., generating adequate or inadequate responses for only 32 to 63% of the items). The compliance of 3 students (1 in the fact-format condition and 2 in the text-format condition) could not be rated due to loss of their study protocols as a result of tape-recorder malfunction.

**Imagery students.** Across the fact- and text-format conditions, 76 percent of the imagery subjects demonstrated adequate compliance with their processing instructions by generating images (adequate or inadequate) for two-thirds of the facts. An example of an adequate image for the fact that the Canadian Shield is the core of the North American continent could be "the Canadian Shield is like an actual shield in the core of the middle of Canada". This image clearly depicts both the fact and the region. An example of an inadequate image for the fact that the Canadian Shield covers about 40 percent of Canada could be "so it's a big shield". While this image depicts the region, it does not depict the fact. Data of students who did not
demonstrate acceptable compliance with processing instructions were excluded. In
the fact-format condition, this involved exclusion of data for one subject who
produced images (adequate or inadequate) for only 55% of the items and his data
were excluded from the analyses. In the text condition, data from six students were
excluded. These subjects produced images (adequate or inadequate) for only 37% to
63% of the items.

Matching Task

One point was scored for each item matched to its corresponding
physiographic region. The mean matching scores for each group are presented in
Table 5. Descriptive statistics for the primary analysis are found in the left columns
of this Table. The scores were approximately normally distributed, with
homogeneous variances as indicated by Levene’s test (Howell, 1992). Due to
unequal n’s, the data were analyzed using the general linear model approach to the
analysis of variance (Huitema, 1980; Kirk, 1982). Both processing condition (3) and
format condition (2) were between-subject variables. The analysis revealed that
there were no significant main effects of either processing or format and there was
not a significant processing by format interaction.

As was outlined in the introduction, six planned comparisons were of
principal interest and these were conducted using the Dunn-Bonferroni procedure
(Howell, 1992; Kirk, 1982) to control the familywise Type 1 error rate (p < .05 for
the set of contrasts). Within the text-format condition, all three matching means
were contrasted. Within the fact-format condition, the three pairwise contrasts were
also made. There were no significant differences for matching performance as a
Table 5

Means and Standard Deviations for Matching Task as a Function of Condition for Primary and Secondary Analyses

<table>
<thead>
<tr>
<th>Condition</th>
<th>Primary Analysis</th>
<th>Secondary Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
</tr>
<tr>
<td>Fact Format</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaborative-Interrogation</td>
<td>17</td>
<td>26.12a</td>
</tr>
<tr>
<td>Imagery</td>
<td>14</td>
<td>21.71a</td>
</tr>
<tr>
<td>Self-Study</td>
<td>18</td>
<td>24.17a</td>
</tr>
<tr>
<td>Text Format</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaborative-Interrogation</td>
<td>11</td>
<td>25.00a</td>
</tr>
<tr>
<td>Imagery</td>
<td>11</td>
<td>26.82a</td>
</tr>
<tr>
<td>Self-Study</td>
<td>18</td>
<td>22.17a</td>
</tr>
</tbody>
</table>

Note: Within the fact and text formats, means sharing the same subscript do not differ significantly from one another. The total possible score for the matching task was 40. For the primary analysis N = 89; for the secondary analysis N = 73.
result of use of elaborative interrogation versus imagery versus the student’s own study techniques, for either format.

In light of previous research findings for the large effect size of elaborative interrogation in comparison to a reading-to-understand control group for matching performance, the lack of enhancement revealed by this primary analysis merits further investigation. In the current study, as was reported previously, adequate elaborations were generated for 15% of the items to be elaborated. Comparatively, this is a small percentage as other studies have noted adequate elaborative-interrogation responses on the order of 35% to 75% of total responses (e.g., Martin & Pressley, 1991; Pressley et al., 1988; Willoughby et al., 1993). Therefore a secondary analysis was conducted.

In this reanalysis, a median split on the basis of percentage of adequate elaborative-interrogation responses was conducted to form two groups—high- versus low-adequate elaborators. A median split was selected as it would result in a sufficient n for each of the elaborative-interrogation and imagery groups and would maintain equivalence in the number of subjects in each of the elaborative-interrogation and imagery groups. All subjects, except those for which response quality could not be rated, were included to conduct the median split. Prior to splitting at the median, no consideration was given for the percentage of total (adequate and inadequate) elaborative-interrogation responses. There were no differences in the mean prior knowledge scores of the high- versus low-adequate elaborative-interrogation groups within the fact- and text-format conditions (M = 23.7, SD = 9.6 for high-adequate fact group; M = 21.8, SD = 4.13 for low-adequate
fact group; \( M = 24.4, SD = 7.8 \) for high-adequate text group; \( M = 21.3, SD = 3.7 \) for low-adequate text group).

A median split of imagery subjects occurred on the basis of the percentage of adequate imagery responses generated by each imagery subject. For the imagery groups, there was also no difference in the mean ratings of prior knowledge for the high-adequate versus the low-adequate imagery students in either the fact- or text-format conditions (\( M = 22.9, SD = 5.6 \) for high-adequate fact group; \( M = 20.7, SD = 4.0 \) for low-adequate fact group; \( M = 23.0, SD = 4.1 \) for high-adequate text group; and \( M = 24.3, SD = 4.2 \) for low-adequate text group). Only those elaborative-interrogation and imagery subjects who were in the top half of the respective median splits were retained as subjects for the secondary analysis. All students in the self-study conditions were retained for this secondary analysis. The mean matching scores and revised \( n \)'s for each of the six groups are presented in Table 5 (see the columns labelled as Secondary Analysis).

Due to both unequal \( n \)'s and heterogeneity of variance (\( t (26) = 2.24, p < .05 \)) as a result of the median splits, planned comparisons for the secondary analysis were conducted using the Welch-Satterthwaite solution (Howell, 1992). For the six planned comparisons, the Type I error rate was set at .15 familywise, or .025 per comparison. Although this is a slightly more liberal approach to controlling Type I error, it controls the familywise error rate at the same level as an ANOVA which would test each of the two main effects and the interaction effect at the .05 level (i.e., .15 familywise, e.g., Woloshyn et al., 1992). Thus, the Type I error rate is reasonable, as failure to obtain an advantage for elaborative interrogation on the
matching task might deter further research on the technique's utility with text. Within the fact- and text-format conditions, comparisons of the elaborative-interrogation group and the imagery group with the self-study control group were conducted with one-tailed tests, as the researcher was interested only in whether the former processing conditions enhanced performance relative to the control condition. Within each format, the comparisons of the elaborative-interrogation and imagery means were conducted using a two-tailed test.

For this secondary analysis of the matching data within the fact-format condition, the elaborative-interrogation group significantly outperformed both the imagery and self-study groups, smaller $t (25) = 2.11, p < .025$. The matching performance of the two latter groups did not differ. For the text-format condition, both the elaborative-interrogation and imagery groups significantly outperformed the self-study control group, smaller $t (20) = 2.23, p < .025$. The performance of the elaborative-interrogation and imagery groups did not differ.

The results of the primary and secondary analyses indicated that the efficacy of elaborative interrogation for matching performance was related to the quality of elaborative-interrogation response, that is to the generation of adequate elaborative-interrogation responses. In order to further investigate the effect of quality of elaborative-interrogation responses on matching performance, the conditional probabilities for each elaborative-interrogation response type (i.e., adequate, inadequate, no response and not attempted) were calculated using all students included in the primary analysis. The probabilities were calculated by dividing the number of questions which were answered correctly and for which the particular
response type was generated during study, by the total number of correctly answered questions. The mean conditional probabilities for each response type for the fact- and text-format conditions for the matching questions are presented in Table 6. Since there were so few "other" responses, the conditional probabilities associated with this response type are not particularly informative.

Post-hoc comparisons of conditional probabilities of correct matching, within the fact-format condition, were conducted using the Games-Howell procedure due to unequal n's and heterogeneity of variance (Kirk, 1982; Howell, 1992). Only one comparison was significant. Generation of an adequate response resulted in a significantly greater probability of a correct matching response than generation of an inadequate elaborative-interrogation response, $q_{(4, 32)} = 6.5, p < .01$. Within the text-format condition, conditional probabilities of a correct matching response were contrasted using Tukey's HSD (Kirk, 1982). Though the probability associated with an adequate response was descriptively greater than that associated with an inadequate response, the difference was not significant. None of the conditional probabilities differed significantly.

**Factual Multiple-Choice Questions**

One point was awarded for each correctly-answered factual MC question; the total possible score was 20. The mean scores for each of the six groups for the primary analysis for the factual MC questions are presented in Table 7 (see left columns regarding Primary Analysis). An analysis of variance using linear regression revealed no significant main effects of processing or format, and no significant processing by format interaction effect. Again, six comparisons between
Table 6

Conditional Probability of Correct Matching Response as a Function of the Quality of Elaborative-Interrogation Response

<table>
<thead>
<tr>
<th>Condition</th>
<th>No. of Items</th>
<th>n*</th>
<th>M</th>
<th>SD</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact Format</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>107</td>
<td>17</td>
<td>.86*</td>
<td>.18</td>
<td>15.7</td>
</tr>
<tr>
<td>Inadequate</td>
<td>459</td>
<td>17</td>
<td>.60*</td>
<td>.16</td>
<td>67.5</td>
</tr>
<tr>
<td>No Response</td>
<td>51</td>
<td>15</td>
<td>.81*</td>
<td>.22</td>
<td>7.5</td>
</tr>
<tr>
<td>Not Attempted</td>
<td>60</td>
<td>13</td>
<td>.68*</td>
<td>.23</td>
<td>8.8</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>2</td>
<td>.75*</td>
<td>.35</td>
<td>0.5</td>
</tr>
<tr>
<td>Text Format</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>85</td>
<td>11</td>
<td>.74*</td>
<td>.24</td>
<td>19.3</td>
</tr>
<tr>
<td>Inadequate</td>
<td>295</td>
<td>11</td>
<td>.57*</td>
<td>.13</td>
<td>67.1</td>
</tr>
<tr>
<td>No Response</td>
<td>56</td>
<td>11</td>
<td>.62*</td>
<td>.29</td>
<td>12.7</td>
</tr>
<tr>
<td>Not Attempted</td>
<td>3</td>
<td>1</td>
<td>.67*</td>
<td>-</td>
<td>0.7</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1</td>
<td>0.00*</td>
<td>-</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Note. Means within each format sharing the same subscript do not differ significantly.
* Indicates the number of subjects generating the stated response type.
* Mean which was not included in analysis.
Table 7

Means and Standard Deviations for Factual Multiple-Choice Questions as a Function of Condition for Primary and Secondary Analyses

<table>
<thead>
<tr>
<th>Condition</th>
<th>Primary Analysis</th>
<th></th>
<th>Secondary Analysis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>n</td>
</tr>
<tr>
<td>Fact Format</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaborative-Interrogation</td>
<td>17</td>
<td>9.76</td>
<td>2.22</td>
<td>10</td>
</tr>
<tr>
<td>Imagery</td>
<td>14</td>
<td>8.93</td>
<td>2.40</td>
<td>9</td>
</tr>
<tr>
<td>Self-Study</td>
<td>18</td>
<td>10.06</td>
<td>3.28</td>
<td>18</td>
</tr>
<tr>
<td>Text Format</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaborative-Interrogation</td>
<td>11</td>
<td>10.82</td>
<td>2.86</td>
<td>9</td>
</tr>
<tr>
<td>Imagery</td>
<td>11</td>
<td>10.00</td>
<td>3.07</td>
<td>9</td>
</tr>
<tr>
<td>Self-Study</td>
<td>18</td>
<td>9.22</td>
<td>2.88</td>
<td>18</td>
</tr>
</tbody>
</table>

Note. Within the fact and text formats, means sharing the same subscript do not differ significantly from one another. The total possible score for the factual multiple-choice questions was 20. For the primary analysis N = 89; for the secondary analysis N = 73.
the six means were of principal interest, that is, the three pairwise comparisons within the fact- and text-format conditions. The family-wise Type I error rate was controlled using the Dunn-Bonferroni procedure with an overall alpha set at .05. None of the pairwise comparisons was significant.

As in the secondary analysis of the matching data, the secondary analysis of the factual MC data included subjects from the top-half of the median splits of the elaborative-interrogation and imagery groups and all self-study subjects. The means and standard deviations for the revised groups are available in Table 7 (see the right columns labelled Secondary Analysis). Due to unequal n’s and heterogenous variances (t (26) = 2.49, p < .05) resulting from the median splits, the planned comparisons were conducted using the Welch-Satterthwaite solution. The six planned comparisons were conducted with the overall Type I error rate set at .15, or .025 per comparison. Comparisons of each of the experimental group means with the self-study group mean were one-tailed tests, while the comparison of the elaborative-interrogation and imagery means were conducted using a two-tailed significance test. There were no significant differences for any of the planned comparisons for the fact- or text- format conditions.

The relationship between the quality of elaborative-interrogation response and production of a correct factual MC question response was investigated by calculating the conditional probabilities of correct responding. Using data from all students included in the primary analysis, conditional probabilities of a correct factual MC response given a particular type of elaborative-interrogation response were calculated. The conditional probabilities for an adequate response, an inadequate
response, no response, not-attempted items, and other responses are presented in Table 8. Since there were so few "other" responses, the conditional probabilities associated with this response type are not particularly informative and were not included in the post-hoc analyses.

Due to heterogeneity of variance, the conditional probabilities associated with the adequate, inadequate, no response and not attempted categories for both the fact- and text-format conditions were contrasted using the Games-Howell procedure. There were no significant differences between the conditional probabilities of correct factual MC response as a result of quality of elaborative-interrogation response for either format condition.

Higher-Level Multiple-Choice Questions

For the higher-level MC questions, the total possible score was 10, with one point given for each correct response. Although n's were unequal, the variances were homogeneous. Descriptive statistics for the higher-level MC questions are available in Table 9 (see the columns to the left, which are labelled Primary Analysis). An analysis of variance conducted by linear regression revealed only one significant effect; there was a significant effect of processing, F (2, 83) = 3.43, p < .05. Therefore, the mean performance of at least one processing condition, averaged across both format conditions, on the higher-level MC questions differed significantly from the mean of at least one of the other processing conditions, averaged across format conditions. The planned comparisons revealed the pattern of performance differences between processing conditions.

The six planned comparisons, that is comparisons of the means within the fact-
Table 8

<table>
<thead>
<tr>
<th>Condition</th>
<th>No. of Items</th>
<th>p*</th>
<th>M</th>
<th>SD</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact Format</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>33</td>
<td>15</td>
<td>.52*</td>
<td>.41</td>
<td>9.7</td>
</tr>
<tr>
<td>Inadequate</td>
<td>241</td>
<td>17</td>
<td>.50*</td>
<td>.16</td>
<td>70.9</td>
</tr>
<tr>
<td>No Response</td>
<td>33</td>
<td>14</td>
<td>.37*</td>
<td>.35</td>
<td>9.7</td>
</tr>
<tr>
<td>Not Attempted</td>
<td>32</td>
<td>13</td>
<td>.45*</td>
<td>.44</td>
<td>9.7</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1</td>
<td>1.00*</td>
<td>--</td>
<td>0.3</td>
</tr>
<tr>
<td>Text Format</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>25</td>
<td>11</td>
<td>.58*</td>
<td>.42</td>
<td>11.4</td>
</tr>
<tr>
<td>Inadequate</td>
<td>144</td>
<td>11</td>
<td>.54*</td>
<td>.19</td>
<td>65.4</td>
</tr>
<tr>
<td>No Response</td>
<td>47</td>
<td>11</td>
<td>.53*</td>
<td>.26</td>
<td>21.4</td>
</tr>
<tr>
<td>Not Attempted</td>
<td>2</td>
<td>1</td>
<td>0.00*</td>
<td>--</td>
<td>0.9</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>1</td>
<td>0.00*</td>
<td>--</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Note. Means within each format sharing the same subscript do not differ significantly.
* Indicates number of subjects who generated the stated response type.
* Mean which was not included in analysis.
Table 9

Means and Standard Deviations for Higher-Level Multiple-Choice Questions as a Function of Condition for Primary and Secondary Analyses

<table>
<thead>
<tr>
<th>Condition</th>
<th>Primary Analysis</th>
<th>Secondary Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
</tr>
<tr>
<td>Fact Format</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaborative-</td>
<td>17</td>
<td>4.12&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>Interrogation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imagery</td>
<td>14</td>
<td>4.00&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>Self-Study</td>
<td>18</td>
<td>3.78&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>Text Format</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaborative-</td>
<td>11</td>
<td>4.45&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>Interrogation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imagery</td>
<td>11</td>
<td>3.64&lt;sub&gt;ab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Self-Study</td>
<td>18</td>
<td>2.61&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

Note. Within the fact and text formats, means sharing the same subscript do not differ significantly from one another. The total possible score for the higher-level multiple-choice questions was 10. For the primary analysis N = 89; for the secondary analysis N = 73.
and text-format conditions, were conducted following the Dunn-Bonferroni procedure with the overall Type I error rate set at .05 (i.e., \( p < .0083 \) per comparison), with cutoff \( t(83) = 2.71, MS_e = 2.41 \). There were no significant differences within the fact-format condition. However, in the text-format condition, the elaborative-interrogation mean was significantly greater than the self-study mean, \( t(83) = 2.79 \). The imagery and self-study means did not differ. As can be seen from the descriptive data for the primary analysis in Table 9 (see left columns labelled Primary Analysis), while the elaborative-interrogation fact-format mean was descriptively greater than the corresponding self-study mean, the difference in the mean performance of the two processing conditions was significant only for the text-format condition. Therefore, the main effect for processing seems to have mainly resulted from the performance difference in the text-format condition.

As a result of the unexpected finding of enhancement of higher-level MC performance for students complying with elaborative-interrogation instructions over their corresponding self-study controls, protocols of all students in the text-format condition were scored for instances of relational processing. Relational processing was considered to be a type of generative processing which was critical in performance on such higher-level learning outcomes (e.g., Mayer, 1987a, 1987b). Responses for each fact were rated as to whether or not relational processing occurred. Relational processing was rated as occurring for the item if the student linked information about two or more regions or two or more facts within a region. This linkage could involve making comparative statements which identified similarities or differences between regions, comparisons which were not presented in
the text. For example, some students compared heights within the Appalachian region and concluded that the heights were highest in the interior and got progressively lower as one approached the ocean. Relational processing was also considered to have occurred if students inferred a general explanation or principle based on linking two or more facts. For example, some students inferred that there must be something about substances in water that decayed or were transformed into oil and gas because areas associated with oil and gas were also areas with water or where water had been.

Ratings of instances of relational processing were made by two raters, who scored 30 percent of the protocols, and interrater reliability was calculated using Cohen’s kappa. Interrater reliability scores for the elaborative-interrogation, imagery and self-study protocols respectively were .84, .96, and .87.

Since almost half of the students in the self-study text-format group were rated as not using any relational processing, use of parametric statistics to compare the mean scores of the elaborative-interrogation and self-study groups was not possible. Therefore the Wilcoxin Rank-Sum Test (Howell, 1992) was used to contrast the relational-processing scores of the elaborative-interrogation and self-study text-format groups. The Wilcoxin test results indicated that the two groups did differ significantly in the tendency of the elaborative-interrogation group to produce more relational processing statements than the self-study group, $W_s (11, 17) = 98$, $p < .01$ ($M = 6.4$, $SD = 4.2$ for the elaborative-interrogation group; $M = 2.1$, $SD = 3.7$ for the self-study group). In addition, 13 of 17 elaborative-interrogation text-format students generated answers for 1 to 3 of the later-administered higher-level MC
questions as part of their relational processing. The imagery text-format group provided few instances of relational processing \((M = 1.8 \text{ instances}, \ SD = 2.2)\).

The secondary analysis for the higher-level MC questions paralleled the other secondary analyses. Descriptive data for the revised experimental groups and the self-study controls are available in Table 9 (see right columns labelled Secondary Analysis). While the \(n\)'s were unequal due to the median split, the variances were homogeneous. Therefore, the six planned comparisons were conducted using the Dunn-Bonferroni procedure. Overall Type I error was controlled at .05 familywise. There were no significant differences between groups in the fact-format condition. As in the primary analysis for the text-format condition, the mean higher-level MC performance was significantly greater for the elaborative-interrogation group in comparison to the self-study group, \(t(67) = 3.44, MS_e = 2.14\). The imagery and self-study group means did not differ significantly.

**Analyses Removing Not-Attempted Items**

In order to determine if the primary analyses, especially for the fact-format conditions, were affected by inclusion of matching and multiple-choice questions corresponding to facts not attempted during study, items related to the Western Cordillera were removed. Items not attempted by students in the elaborative-interrogation and imagery groups involved facts for the Western Cordillera region. Not-attempted items were more common to the fact- than the text-format conditions. The number of students rated as having not-attempted items in the elaborative interrogation fact-format, imagery fact-format, elaborative interrogation text-format, and imagery text-format conditions were 13, 9, 1, and 0, respectively. Due to
removal of questions concerning the Western Cordillera, the total possible matching
score was 34, the total possible factual MC score was 17, and the total possible
higher-level MC score was 8.

As in the primary analyses, six planned comparisons were conducted for each
of the three revised dependent measures, that is the revised matching, factual MC
and higher-level MC scores. For the revised mean matching and mean factual MC
scores, comparisons were conducted using the Dunn-Bonferroni procedure. As for
the primary analyses of the matching data, there were no differences between groups
within the fact- or the text-format conditions. There were also no significant
differences between mean scores for the factual MC questions within the fact- and
within the text-format conditions. The six planned comparisons of mean scores for
the higher-level MC questions were contrasted using the Welch-Satterthwaite
solution due to heterogeneity of variance and unequal n’s. As in the primary and
secondary analyses, the only significant contrast was that in the text-format
condition, the elaborative interrogation students \((M = 3.45, SD = 1.37)\) significantly
outperformed the self-study students \((M = 2.22, SD = 1.26), t (19) = 2.42, p < .025.\)

Summary

In summary, regardless of presentation format, use of elaborative-interrogation
resulted in significantly better matching performance than the self-study groups, with
this finding dependent on the production of a sufficient number of adequate
elaborative-interrogation responses. Students instructed to use imagery outperformed
their self-study controls, only for the text-format condition, with this effect qualified
by the production of a sufficient number of adequate images. For the factual MC
questions for either format condition, there was no enhancement of performance as a result of use of either elaborative interrogation or imagery relative to students' use of their own study techniques. For the higher-level MC questions, elaborative interrogation produced descriptively better performance than the self-study controls for the fact-format condition, but significantly outperformed the self-study controls only in the text-format condition. Imagery did not enhance higher-level MC performance relative to the respective control groups in either format condition.
CHAPTER IV
DISCUSSION

There were three predominant interests of the present research: to determine if the elaborative-interrogation advantage for matching performance obtained when students processed individually-presented facts would also occur when students processed text, to determine if elaborative interrogation would enhance performance on criteria used to assess learning of text content in university settings, and to evaluate the efficacy of elaborative interrogation for matching and academic criteria against performance resulting from the study techniques students already use. The contrasts between students instructed to use elaborative interrogation and students using their own study techniques were of primary importance; contrasts between students instructed to use imagery and the self-study students were of lesser interest. Instead of presenting a discussion of the processing of the self-study students separately from the other two issues presented, this issue will be dealt with as it becomes pertinent to discussion of performance on the matching task and then to the discussion for the academic criteria, the multiple-choice questions. Next, the author will consider academic implications of the present findings. Finally, issues in need of further research and directions for future studies will be discussed.

Matching Performance as a Result of Use of Elaborative Interrogation and Imagery with Expository Text

Regardless of whether students using elaborative interrogation were studying materials resembling previously-used study materials or new, more sophisticated text materials, a certain subset of students did achieve significantly better matching
scores than the self-study controls. For both formats, the enhancement of matching performance resulting from use of elaborative interrogation was constrained by the quality of the elaborative-interrogation responses generated. That is, a significant enhancement of matching performance was obtained only when students who generated a minimal number of adequate elaborations (i.e., those who generated adequate elaborations for less than 12 percent of the items presented for study) were removed from the analysis. When all students complying with elaborative-interrogation instructions were included and there was no consideration of the number of adequate responses generated, there was no enhancement of matching as a result of use of elaborative interrogation with either the fact or the text format. Simply attempting to comply with elaborative-interrogation instructions was not sufficient to enhance matching performance.

In other studies in which university students have used elaborative interrogation, generation of adequate elaborations has not been problematic as students have generated adequate elaborations for 35 to 75 percent of the facts presented for study. About half of the students in the present study had difficulty using the elaborative-interrogation technique to generate adequate elaborations, as they generated adequate elaborations for less than 12 percent of the facts. The question then becomes why a group of students in the present study generated only minimal numbers of adequate elaborations and why generation of adequate elaborations would be related to the efficacy of elaborative interrogation for matching performance.

Potential explanations for the relationship between generation of adequate elaborative-interrogation responses and facilitation of matching performance. There
are several potential explanations for the failure of a group of elaborative-interrogation students to generate more than a minimal number of adequate responses and the resulting failure of elaborative interrogation to enhance matching performance when the data of these students were included. The first potential explanation offered is that students who generated minimal adequate elaborative-interrogation responses lacked motivation to comply with task instructions or forgot their task and reverted to use of their own study techniques. If this occurred, their performance on the matching task should not have differed from the self-study controls, and this should have depressed the overall performance of the elaborative-interrogation group. Even though there were anecdotal reports that students in the elaborative-interrogation condition found their task effortful, data suggest that students generating few adequate responses were not reverting to their own study techniques but were instead trying to comply with elaborative-interrogation instructions. First, adequate elaborations occurred throughout study of the passage and were not limited to facts at the beginning of the passage. Second, even inadequate elaborations were attempts to make sense of the fact, though poor in quality. Inadequate elaborations were not attempts to use another processing technique. Therefore, the low rate of adequate elaborations did not seem to result from lack of motivation or use of another processing technique.

A second potential explanation is that students who generated minimal adequate elaborations were lower in prior knowledge for Canadian geography than their counterparts who generated a greater number of adequate elaborations; and it was the level of prior knowledge which mediated the enhancement of matching
performance for this second group relative to the self-study controls. There were no significant differences in rated level of prior knowledge between students in the bottom and the top half of the median split for adequate elaborations for either the fact or text formats; the rated level of knowledge was low for all groups. Therefore, the level of prior knowledge does not account for the differences in number of adequate elaborations generated nor does it account for the lack of enhancement of matching performance when low-adequate elaborators are included.

The third and most likely possibility is that quality of elaborative-interrogation response is critical to the technique's enhancement of matching performance. For the fact-format condition, the probability of correctly answering a matching item was significantly greater if an adequate rather than an inadequate elaborative-interrogation response was generated. For the text-format condition, the probability of making a correct matching response was only descriptively greater, but not significantly greater, for an adequate than an inadequate response. In both cases, the probability of a correct matching response associated with generating an inadequate response was similar to that of students in the self-study group making a correct match. For the present study, adequate elaborations always clearly linked the fact to the region specified and only the region specified. For example, in generating an adequate response for the fact that the Interior Plains are rich in oil and gas, one student responded by linking the fact to the Edmonton oiler hockey team. This response provided a direct link between the fact and the region which would distinguish the Interior Plains as the matching response and eliminate other possible matching responses. In contrast, inadequate responses attempted to answer why the
fact made sense without linking it to any particular region or by using a general theme such as glaciation.

In summary, enhancement of matching performance in the present study was dependent on the frequent generation of adequate elaborations. Adequate elaborations provided a clear association between the fact and the region for which it was true, thus providing a distinctive encoding of the association. The finding that elaborative interrogation could enhance matching performance relative to the self-study control group for both the individually-presented facts and collection-type text provides support that the technique does have relevance for the types of materials that university students are asked to study. It also can be more effective than the techniques students often use to study. The enhancement of matching performance was expected due to the large advantage for elaborative interrogation versus a rote-processing condition obtained in previous research with individual facts (e.g., Martin & Pressley, 1991; Pressley et al., 1988; Woloshyn et al., 1990, 1992; Willoughby et al., 1993).

The importance of generation of an adequate response, which allowed discrimination between matching responses, to the efficacy of the technique is consistent with some other research on elaborative interrogation (e.g., Martin & Pressley, 1991; Willoughby et al., 1993; Woloshyn et al., 1990, exp. 2). For example, Martin and Pressley (1991) found that elaborative-interrogation responses which specifically tied Canadian provincial facts to the correct province enhanced matching performance relative to the reading-to-understand control group. In contrast, responses which confused the association by activating irrelevant
information about other similar provinces did not enhance matching performance. Use of irrelevant information in elaborative-interrogation responses is not expected to enhance learning (Pressley et al., 1992).

Further evidence for the importance of an adequate response comes from a few elaborative-interrogation studies, which found an advantage to generating an adequate response. For example, a significantly greater probability of a correct matching response occurred when students generated an adequate rather than an inadequate response for facts about Canadian universities (Woloshyn et al., 1990, exp. 2). By further classifying adequate responses, Willoughby et al. (1993) found a significant advantage for factually-correct adequate elaborations over other adequate elaborations for correct matching responses. These factually correct adequate elaborations made the relationship between the fact and its referent clear, allowing students to distinguish between matching responses (Willoughby et al., 1993). The findings of the present study and the Willoughby et al. study suggest that failure to obtain a significant advantage for adequate over inadequate elaborations may result from inclusion of elaborations which do not distinguish the association in the adequate category. A matching-performance advantage for elaborative-interrogation responses which distinguish the correct response from other possible responses is consistent with the theory of the type of processing critical to recognition memory (e.g., Hunt & Einstein, 1981). Since recognition memory is considered to be dependent on proposition-specific processing which encodes the distinctiveness of the item and allows for distinguishing correct responses from alternates.

The utility of imagery for the matching task. Continuing the comparison of
imagery with elaborative interrogation, the findings of the present study suggest that imagery can enhance matching performance for text materials in comparison to students using their own studying techniques. As was the case for elaborative interrogation, enhancement of matching as a result of use of imagery was dependent on the generation of adequate images, that is, images that linked the fact with the region. Students had some difficulty implementing imagery with the fact and text materials, and only students who generated adequate images benefitted from use of the technique. There was no enhancement of matching performance for imagery subjects who generated an image for only the fact, or only the region, or who generated an unrelated image.

Imagery is considered to have been effective in the text condition for students generating adequate images because these images involved generative processing of the fact-region association which distinguished the correct matching response from alternative responses. That imagery was as effective as elaborative interrogation for processing the text material, when adequacy of the responses was considered, is consistent with previous research which has demonstrated significant enhancement of matching performance through use of either technique (e.g., Pressley et al., 1988, exp. 3; Woloshyn et al., 1990). The failure of use of imagery to enhance matching performance in the fact-format condition when adequacy of images was considered is inconsistent with the findings of previous research (e.g., Pressley et al., 1988, exp. 3; Woloshyn et al., 1990). However, the self-study control group, particularly the fact-format control group, was a more stringent group than the previously used reading-to-understand control group.
Study techniques used by the self-study students. Prior to summarizing the conclusions concerning the utility of the instructed processing techniques on matching performance for collection-type text, it is important to discuss the processing of the control group to which the performance of the other groups was compared. Although students in the self-study group often did more than just read and reread the information for understanding, for the most part their processing was rote. In fact, they engaged primarily in reading and rereading, which was accompanied by various text-noting behaviors which appeared not to be generative in nature. Instances of generative processing occurred in the protocols of the majority of students but this type of processing was applied to a very small percentage of the ideas presented in the passage. The exception to this was the substantial amount of elaborative activity in the protocols of two self-study fact-format students.

That the self-study students engaged primarily in rote processing provides evidence from concurrent reporting during study which is consistent with the findings of other researchers (e.g., Feldt, 1990, Wade et al., 1990) who used probe or retrospective measures. These researchers also concluded that students rely on rote processing when studying text. Forty percent of the students in the self-study fact-format condition and 48 percent of the students in the self-study text-format condition were comparable to a cluster of students identified by Wade et al., (1990) as "memorizers". Memorizers rely solely on rote-learning and note text using predominantly highlighting or underlining. Such memorizers comprised one third of their students. Given the study techniques identified from the think-aloud protocols
of the present study, it would appear that the use of reading-to-understand control
groups in previous elaborative-interrogation research (e.g., Martin & Pressley, 1991;
Pressley et al., 1988; Woloshyn et al., 1990) resulted in processing not unlike the
processing most students do use; therefore, it was a reasonable control condition.
That a couple of students chose to elaborate facts, and elaborated by considering
why facts made sense, indicates that elaborative interrogation may be a study
technique which students would be motivated to use.

In summary, there is evidence that elaborative interrogation can be used
successfully by some students to process expository text (i.e., collection-type text) in
order to enhance their matching performance in comparison to the rote-processing
techniques most students select. Though the effect of quality of elaborative-
interrogation response on performance measures was not a particular goal of the
present study, the current findings support that quality of elaborative-interrogation
response is crucial to the technique’s effectiveness. There was a significant
advantage for matching performance when students generated responses which
distinguished the fact-region association.

Although elaborative interrogation can be useful for students studying
collection-type text when matching performance is assessed, its effectiveness on
performance on academic criteria was also of concern. The discussion will now
focus on these academic outcome measures—factual and higher-level multiple-choice
questions.

**The Utility of Elaborative Interrogation and Imagery for Multiple-Choice Questions**

**Factual multiple-choice questions.** There was no facilitation of performance on
factual MC questions relative to the appropriate self-study group for students using elaborative interrogation or imagery when facts were presented individually or when facts were presented in a text passage. There was no facilitation when only students complying with elaborative-interrogation or imagery instructions were considered nor when adequacy of the elaborative-interrogation or imagery responses was considered. Although both the matching and factual MC questions tap recognition memory, there are differences between the two measures which may account for failure of elaborative interrogation and imagery to enhance performance on the factual MC questions. While the matching questions tapped recognition of fact-region associations, the factual MC questions tapped recognition of these fact-region associations as well as other associations presented in the passage. Elaborative-interrogation and imagery instructions were intended to focus attention and processing to the fact-region associations only. The techniques self-study students used resulted in some learning as students were able, on average, to answer 47 to 50 percent of the factual MC questions correctly. It is important to remember that these questions, as well as the other questions used, were pretested and students were unable to answer them correctly even at chance levels.

The rote processing techniques students have developed seem to serve them well in performance on factual MC questions. Other studies which compared students who were instructed in the use of generative techniques to link ideas within text together have also failed to obtain an advantage for factual MC test performance relative to either a self-study group or a reading control group (e.g., Brooks et al., 1983; Jonassen, 1984; Holley et al., 1979).
Higher-level multiple-choice questions. The most important finding from this study, is the finding that elaborative-interrogation significantly enhanced performance on the higher-level MC questions in comparison to the techniques used by the self-study controls when students processed text. This finding did not depend on generation of adequate elaborative-interrogation responses but occurred both for the analysis including subjects who complied with the processing instructions for their condition and for the analysis including only subjects who generated a high level of adequate responses. The processing which resulted from the use of imagery did not result in superior performance to the processing of the self-study controls in either analysis.

Clearly the finding of enhancement of performance on higher-level MC questions as a result of use of elaborative interrogation in comparison to the study methods students preferred to use is an important but unexpected finding. Though elaborative-interrogation was expected to primarily prompt generative, proposition-specific processing, the students also used the technique to engage in relational processing. These elaborative-interrogation text-format students engaged in significantly more relational processing than the self-study text-format students. In attempting to make the facts sensible for the respective region, students often went beyond the information, to infer why a region had a particular topography either by using information presented for another region or by using an idea presented for the region in question. For example, in explaining a topographic feature, a student could infer that a glacier from one region had also moved into another region. Or, a student might explain that the Interior Plains had oil and gas by using another fact in
the passage, the fact that the plains once had warm, shallow seas. The student would then infer that something about a warm, shallow sea, such as plant life might have something to do with the formation of oil and gas.

Thus, students in the elaborative-interrogation text-format condition were also going beyond the information presented by comparing regions and considering implications of ideas presented in order to make the facts sensible. By attempting to fit ideas together and understand their implications, these students were engaging in relational processing, a type of generative processing which is considered critical to performance on such higher-level questions. Since the self-study text-format students engaged in minimal relational processing, the text-type (i.e., collection-type) is not considered to have prompted the relational processing of the elaborative-interrogation students. Rather, the results suggest that elaborative interrogation may function to prompt relational processing as well as proposition-specific processing.

The present study provides additional support to other studies which have found a relationship between student self-reports of organizing and evaluating the information studied and performance on higher-level questions (Feldt, 1990; Van Rossum & Schenk, 1984), including higher-level MC questions (Thomas & Bain, 1982). When processing instructions, that is elaborative-interrogation instructions, prompted relational processing, performance on higher-level MC questions was enhanced relative to a control group who engaged in minimal relational processing. In the present study the evidence for relational processing came from self-reports which were concurrent with studying of the passage, rather than retrospective reporting of processing through verbal reports or the completion of self-report
While instructions to use elaborative interrogation enhanced performance, instructions to use imagery were not effective in enhancing higher-level MC performance in comparison to the self-study controls. This is the first time, elaborative interrogation has had an advantage over imagery on a performance measure. Students using imagery to study the text passage, rarely used relational processing and were comparable to the self-study controls in their use of relational processing. Students in the imagery condition were not expected to outperform the self-study controls on the higher-level MC questions because imagery should not allow students to represent abstract relationships between ideas or to represent general principles (e.g., Hunt & Marschark, 1987).

**Academic Implications**

In summary, the present research findings suggest that elaborative interrogation can be useful to students when they study sophisticated text materials in preparation for a commonly-used academic criteria, performance on multiple-choice exams. The main advantage for the study technique was for higher-level MC questions. The techniques students in the self-study group reported using were as effective as both elaborative interrogation and imagery for performance on the factual MC questions. Use of the think-aloud procedure may have interfered with the processing of the self-study groups and may have interfered with their ability to engage in their "real-life" study habits. However, every effort was taken to minimize interference with ongoing processing which might affect the process or outcome of the studying. From the study techniques revealed by the think-alouds, it would seem that the rote-
learning techniques students have developed are not unsuited for learning
information in preparation for factual MC questions. If instructors place value on
higher-level learning outcomes by including higher-level MC questions on their
exams, the present findings suggest that elaborative interrogation would be of
assistance to students and would not impair their performance on factual MC
questions relative to use of their own study techniques.

Future Directions for Research

Although the results of the present study are encouraging for the use of
elaborative interrogation in enhancing learning outcomes important to university-
level study, there are many issues which still need to be resolved, some of which
limit the generalization of the present findings. First, the results of the present study
for higher-level MC questions and matching items need to be replicated with
collection-type text about other content areas and with other types of expository text.
The present research used only one type of text which presented information about
one content area. Many students commented that they found the passage boring
while some found it interesting. It is possible that the results could differ if a more
interesting text passage was used; this would also entail use of a passage related to a
different content area. A more interesting passage might change the processing
activity of the self-study group. These self-study students might engage in more
generative, proposition-specific or relational processing which would result in
reduced effectiveness for elaborative interrogation, since their processing might
already resemble that intended to be prompted by use of elaborative interrogation.
Use of elaborative interrogation with other text types which are expected to prompt
more relational processing, such as problem-solution or comparison text, might also reduce the effectiveness of the technique relative to the self-study techniques for performance on the higher-level MC questions.

There is also a need to more carefully classify the quality of elaborative-interrogation responses. Adequate responses should be subcategorized as clearly distinguishing the fact for the region, or as using prior knowledge which does not distinguish the fact-referent association. Inadequate responses should be subcategorized into "constructive" responses which make sense of presented information by linking it to other ideas or principles extracted from the text, and into "irrelevant" responses which use irrelevant information in an attempt to respond. Use of such categories should assist in clarifying the role of "adequate" elaborations in the technique's effectiveness.

In continuing research concerning the utility of elaborative interrogation for academic measures when students study expository text, the context in which the technique is implemented should be expanded to consideration of learner characteristics. Despite rather extensive training in use of the technique, and demonstration of ability to apply the technique to training materials, some students did not comply well with elaborative-interrogation instructions for the critical study materials. Thus, the study technique cannot be generally recommended to students, as a study method which might assist them with matching tasks. Enhancement of matching performance was dependent on the ability to generate adequate elaborations. Future research needs to address learner characteristics and their implications for recommendation of the technique to students. Such learner
characteristics could include motivational variables, reading ability, and verbal ability. For example, Wittrock and Alesandrini (1990) found that the ability to generate meaning by linking a paragraph of text to prior knowledge through the use of analogy was related to verbal-analytical ability, as measured by the Similarities subtest of the Wechsler Adult Intelligence Scale. It is possible that verbal-analytical ability is related to the ability of students to generate adequate elaborative-interrogation responses, to identify a piece of prior knowledge which is relevant to making a particular fact sensible.

A third potential avenue for future research for elaborative interrogation’s utility with measures of higher-level learning should be adapting elaborative-interrogation instructions so that students could be more flexible and self-regulated in use of the technique. Instructions could prompt a student to make the fact sensible for a particular referent when the fact-referent association is considered to be important, and also to consider why facts are sensible with reference to other information presented in the text.

Thus, prior to attempting to instruct students in the use of the technique in a strategic manner during their general studying of university-level materials, there are several issues relevant to implementation of the technique which remain to be addressed. The results of the present study are encouraging for the eventual utility of elaborative interrogation for students as a self-regulated study strategy. Further research aimed at clarifying the mechanisms mediating the strategy’s effectiveness, along with investigation of the impact of learner characteristics, and other text contexts, should be valuable in providing students a potential strategy. A strategy
which should be of use in their efforts to remember, learn, and apply text information during their university careers.
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APPENDIX A

FAMILIARIZATION PASSAGE FOR TEXT CONDITION

Presently in Canada there is a resurgence of interest in aboriginal peoples. The present reading will provide some general information about two native groups, the Haida and the Iroquois, in order to familiarize you with your task.

**Haida**

The Haida Indians live along the coastal bays and inlets of the Queen Charlotte Islands of British Columbia. Their habitation there has been continuous for at least 6000-8000 years. All Haida belong to one of two clans—the Eagle or the Raven. Clan membership is inherited from the mother and marriages occur between clans. Traditionally, the winter lodgings of the Haida were huge post-and-beam structures covered with split cedar. Large sea-going canoes were used for fishing and catching sea-otters.

**Iroquois**

The Iroquois or the six nations are a confederacy of six tribes including the Seneca, Oncida, and Mohawk. The largest concentrations of Iroquois in Canada are near Brantford, Cornwall, and Montreal. Traditionally, the Iroquois have been a respected military force and they supported the Loyalists and British in the American Revolution. The Iroquois have a matrilineal society, with matrilineal clans named after animals, such as bear, wolf, and hawk. Marriages must occur between members of different clans. Traditionally, the Iroquois lived in stockaded villages, which contained a few to as many as 50 elm- or cedar-barked longhouses. Habitation within a longhouse was based on matrilineal clan membership.
APPENDIX B

FAMILIARIZATION PASSAGE FOR FACT CONDITION

Presently in Canada there is a resurgence of interest in aboriginal peoples. The present reading will provide some general information about two native groups, the Haida and the Iroquois, in order to familiarize you with your task.

**Haida**

The Haida Indians live along the coastal bays and inlets of the Queen Charlotte Islands of British Columbia.

Their habitation there has been continuous for at least 6000-8000 years.

All Haida belong to one of two clans—the Eagle or the Raven.

Clan membership is inherited from the mother.

Marriages occur between clans.

Traditionally, the winter lodgings of the Haida were huge post-and-beam structures covered with split cedar.

Large sea-going canoes were used for fishing and catching sea-otters.

**Iroquois**

The Iroquois are also known as the six nations.

They are a confederacy of six tribes including the Seneca, Oneida, and Mohawk.

The largest concentrations of Iroquois in Canada are near Brantford, Cornwall, and Montreal.

Traditionally, the Iroquois have been a respected military force.

They supported the Loyalists and British in the American Revolution.

The Iroquois have a matrilineal society.

Matrilineal clans are named after animals, such as bear, wolf, and hawk.

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Marriages must occur between members of different clans.

Traditionally, the Iroquois lived in stockaded villages, which contained a few to as many as 50 elm- or cedar-barked longhouses.

Habitation within a longhouse was based on matrilineal clan membership.
APPENDIX C

PILOTING OF STUDY USING TEXT FORMAT

The purpose of the piloting of the proposed study was to work out any unforeseen problems with the procedure, to check timing of different phases of the study, to determine if students could be instructed to use their assigned processing techniques during the familiarization phase, to check for the presence of floor or ceiling effects with the outcome measures, and to obtain some preliminary data concerning the performance of the experimental and control groups.

**Phase 1**

**Subjects.** The sample consisted of 9 introductory psychology students who received bonus point credit toward their psychology grade for participation in the 1.5 hour session.

**Method.** In this phase only the elaborative interrogation and imagery conditions were included. Students were randomly assigned to experimental condition (elaborative-interrogation -- 5 students, imagery -- 4 students). The researcher was most interested in determining if students could deal with the instructions and heavy processing loads involved in complying with instructions for these conditions. First, students received the same familiarization training as outlined in the method section for the main study, using a text passage about two Canadian native groups--the Haida and the Iroquois. Next, students were presented with the text passage about Canadian physiography. The original passage was used and students read information about 7 physiographic regions. The students saw the regions on a map presented by the experimenter. The text passage was presented
and students were instructed to continue using the study technique (elaborative-interrogation or imagery) that they had learned during familiarization. The instructions were identical to those later used in conducting the research, with the following exceptions. Information about timing and cuing of time remaining was excluded. Definitions were not provided. Students proceeded to study the text passage as instructed. Following study, students were asked to complete a 36-question multiple-choice test (see Appendix I re: piloting of multiple-choice questions) and then to complete the 93-item matching task.

Results. Students in both the elaborative-interrogation and imagery groups responded well to the familiarization session. They were able to implement their processing strategy adequately by the time they reached the second topic in the familiarization passage. However, it was clear from student response that the study passage was too lengthy. Students required almost 50 minutes to study the passage and were fatigued. The researcher had intended the studying phase to last 35 to 40 minutes. For the multiple-choice test, the mean number of correct responses for the factual questions was 6.0 for the elaborative-interrogation group. Due to fatigue, only one imagery student agreed to complete the multiple-choice questions and this student answered 13 factual questions correctly. For the higher-level questions, the mean elaborative-interrogation group score was 3.7, while the one imagery subject answered 7 questions correctly. Subjects in both groups completed the matching items. Mean correct responding was 35.7 and 28 for the elaborative-interrogation and imagery groups respectively.
Phase 2

In response to the problems identified in phase 1, the study passage was edited by removing sections of text concerning two physiographic regions—the Innuiton Region and Arctic Coastal Plain, and the Hudson Bay Lowland and Foxe Basin.

Subjects. Six introductory psychology students participated in the second phase of piloting. They received credit toward their psychology grade for their participation.

Method. The same procedure used in phase 1, was again implemented for phase 2. Due to editing of the study passage, 5 multiple-choice questions were eliminated, resulting in 18 factual questions and 13 higher-level questions. Ten matching items had to be eliminated as a result of shortening of the study passage (Total score = 83). Due to the scarcity of subjects, only two conditions were run: the elaborative-interrogation text-format group and the self-study text-format group. These conditions were selected as the elaborative-interrogation group was of primary interest to the researcher and would provide needed information about the required study time which should also be sufficient for the imagery group. The self-study group had not yet been piloted and information was needed about the adequacy of instructions, timing, and performance on outcome measures for this group. Students were randomly assigned to these conditions (elaborative interrogation -- 3 students; self-study -- 3 students).

Results. Again students were able to produce adequate elaborative-interrogation responses by the time they reached the middle of the practice passage, which indicated that the familiarization session was sufficient to allow students to
learn how to implement the requested study technique. Shortening of the study passage resulted in a shortening of the required study time to about 45 minutes. For the elaboration group, the mean performance on factual multiple-choice questions was 7.0, on higher-level multiple-choice questions was 5.7, and on matching items was 30.5. For the self-study control group, the mean score on factual multiple-choice, higher-level multiple choice and matching questions was 10.7, 5.3, and 45, respectively.

As a result of the findings of the second phase, further editing of the passage occurred in order to reduce the study phase to a 40-minute session. In addition, the familiarization passage was shortened slightly to reduce the length of the total session. As a result of editing, changes to the multiple-choice questions and repiloting of these questions was necessitated. The matching test was also shortened. The similarity of matching performance for the elaborative-interrogation and self-study groups was unexpected. It was decided that a fact-format condition for each of the three processing groups should be included in the final study so that any reduction in effectiveness of elaborative interrogation as a result of moving to text material could be evaluated against a fact-format condition, the format used in previous research demonstrating the robust effects of elaborative interrogation.
APPENDIX D

CRITICAL TEXT PASSAGE

Physiography

For a country the size of Canada, it is not surprising that there is a wide diversity of landscapes. Within this diversity, however, it is possible to distinguish a number of physiographic regions that have been subjected to common geological events and that display similar landscapes.

Canadian Shield

The Canadian Shield is the core of the North American continent and covers about 40 percent of Canada in a broad band surrounding Hudson Bay. It contains less than 10 percent of the population and has continually repelled permanent occupation since it has little agriculturally useful land.

Some of the oldest rocks in the world are found in the Canadian Shield, which was formed when continental drift brought at least seven micro-continents together and welded them into a single, geologically complex unit. The mountains produced by the collisions were eroded away over the ages leaving a relatively low, undulating terrain, which may be quite rough in places. The local relief is generally less than 100 metres while the greatest elevations are found in the Torngat Mountains of Labrador and along the eastern coast of Baffin Island. The primary resource is the rich deposits of minerals. These range from precious metals (gold, silver, platinum), to specialty metals (cobalt, titanium, uranium), and the utilitarian metals (iron, nickel, copper, lead, and zinc). The result has been the development of this area in the form of mining towns.

The impact of continental glaciation is very evident. Ice scoured the surface of the land, removing the soil and creating innumerable small depressions in the rock. Thus, most of the Canadian shield is bare rock or has extremely thin soil, while the depressions form lakes, ponds, or wetlands. Where glacial deposits are substantial, such as the Abitibi clay plain in northern Ontario and Quebec, some farming is possible, but widespread, commercial agriculture is generally not feasible on the Canadian Shield. However, the soils are sufficient to sustain slow-growing, primarily coniferous forests that provide raw materials for the lumber and pulp-and-paper industries located in the southern part of the shield. Linked to the energy-intensive mining and pulp-and-paper industries was the harnessing of the hydro-electric power potential of the large northern rivers.

Great Lakes-St. Lawrence Lowland

Surrounding the Canadian Shield is a group of plains, remnants of the
sedimentary rock that once covered this area. Rocks geologically similar to the Canadian Shield provide the base material upon which the dolomites, sandstones, and shales that compose these lowlands and plains rest.

The most southerly of these plains is the Great Lakes-St. Lawrence Lowland. It stretches from southwestern Ontario down the St. Lawrence Valley and incorporates Anticosti Island and small parts of Newfoundland. The rocks are generally horizontal, so the only major relief is provided by the Niagara Escarpment, which is up to 100 metres high, and by the Montréal Regions, a series of granitic intrusions east of Montréal. The rest of the terrain is covered by glacial deposits and is gently rolling except for a large area consisting of eastern Ontario and western Quebec, where deposition of sediments left by the former Champlain Sea produced an almost flat landscape. An excellent soil has developed, and this, in addition to its relatively southern position, has produced a prime agricultural area that has been maintained largely because of its proximity to the main population centres.

Interior Plains

This region is gently rolling and the elevation increases in steps toward the West. The most prominent topographic features are the northwest-southeast-trending escarpments and the associated large hills or plateaus, which define three levels. The Manitoba Lowland (the lowest) is separated from the Saskatchewan Plains (middle level) by the Manitoba Escarpment, which is composed of large hills such as Riding Mountain. Within the highest level, the Alberta Plain, there are a number of large, isolated hills. One such area, the Cypress Hills, was high enough to remain unglaciated. However, the glaciers left thick deposits of debris elsewhere, which developed into excellent soils that attracted nineteenth-century settlers. Meltwater discharge during deglaciation cut large, deep valleys, called coulees, into the plain. Glacial lakes in central Saskatchewan and southern Manitoba left relatively flat terrain when they drained. Where pronounced erosion continues, such as in the Drumheller area of Alberta, badland topography has developed.

Since the rocks that compose the Interior Plains were laid down in a warm, shallow sea, the area is rich in coal and, especially, oil and gas. While Saskatchewan, Manitoba, and British Columbia have some oil, an area from Alberta northward to the Beaufort Sea contains most of it, either as conventional deposits or oil sands. The other primary mineral of the region is potash, mined in eastern Saskatchewan.

Appalachian Region

The Appalachian Region was formed during the collision of North America with Europe. The Notre Dame Mountains, from the Eastern Townships of Quebec to the Gaspe Peninsula, are the highest remnants of the large mountains that have now been rounded by erosion. Eastern New Brunswick, Prince Edward Island, and parts
of western Nova Scotia consist of a gently rolling terrain. Along New Brunswick’s Bay of Fundy coast, a series of hills about 450 metres high stretches toward western Cape Breton Island. Between these and the upland along Nova Scotia’s east coast is the lowland area of the Annapolis Valley, which extends to the plateau interior of Cape Breton. In Newfoundland, the Long Range Mountains (800 metres) from the western side of the island while the remainder is an irregular plateau.

The area presented scattered lowlands suitable for agriculture, while mineral resources reflect the complex geology. Coal fields on Cape Breton Island support a steel industry and deposits of gypsum, potash, and lead/zinc are exploited. However, the potential wealth of the Maritime region lies offshore in the oil fields of Hibernia and Terra Nova on the Grand Banks and in the natural gas deposits of the Scotian Shelf, the traditional fishing areas.

Western Cordillera

The Cordilleras of western North America were formed during the collision of the North American and Pacific plates, which still continues—as those who live along the San Andreas fault will readily recognize. Despite the complex topography and geology, the region can be subdivided into three parallel systems. The Cordillera East section is composed of sedimentary rocks that have folded and faulted to produce a spectacular mountain chain known as the Rockies in the south and the Mackenzie Mountains in the north. Coal deposits located here have been exploited since the late 1800’s.

The Cordillera West region includes the mountains of Vancouver and the Queen Charlotte Islands, the Coast Mountains on the mainland, and a trough between them. The mountains are generally composed of igneous intrusions and reach altitudes of 4000 metres. Between these two mountain belts lies the Cordillera Interior, a mixture of mountains and high plateaus composed of igneous, metamorphic, and sedimentary rock. Both the western and interior parts of the cordilleras are rich in the same types of minerals as are found on the Canadian Shield. These include gold, silver, lead, zinc, and specialty metals such as tungsten and molybdenum.

APPENDIX E

CRITICAL PASSAGE WITH FACTS IDENTIFIED

Physiography

For a country the size of Canada, it is not surprising that there is a wide diversity of landscapes. Within this diversity, however, it is possible to distinguish a number of physiographic regions that have been subjected to common geological events and that display similar landscapes.

Canadian Shield

The Canadian Shield is the core of the North American continent.

It covers about 40 percent of Canada.

It runs in a broad band surrounding Hudson Bay.

It contains less than 10 percent of the population.

It has continually repelled permanent occupation.

It has little agriculturally useful land.

Some of the oldest rocks in the world are found in the Canadian Shield.

The Shield was formed when continental drift brought at least seven micro-continents together and welded them into a single, geologically complex unit.

The mountains produced by the collisions were eroded away over the ages.

Erosion has left a relatively low, undulating terrain, which may be quite rough in places.

The local relief is generally less than 100 metres.

The greatest elevations are found in the Torngat Mountains of Labrador and along the eastern coast of Baffin Island.

The primary resource is the rich deposits of minerals.

Minerals include precious metals (gold, silver, platinum).
Minerals include specialty metals (cobalt, titanium, uranium).

Minerals include utilitarian metals (iron, nickel, copper, lead, and zinc).

The result has been the development of this area in the form of mining towns.

The impact of continental glaciation is very evident.

Ice scoured the land removing the soil and creating innumerable small depressions in the rock.

Most of the Canadian Shield is bare rock or has extremely thin soil.

The depressions form lakes, ponds, or wetlands.

There are some substantial glacial deposits, such as the Abitibi clay plain in northern Ontario and Quebec.

Some farming is possible at glacial deposits.

Widespread, commercial agriculture is generally not feasible on the Canadian Shield.

Soils are sufficient to sustain slow-growing, primarily coniferous forests.

Coniferous forests provide raw materials for the lumber and pulp-and-paper industries located in the southern part of the shield.

The Shield has energy-intensive mining and pulp-and-paper industries.

Energy for these industries is generated by the harnessing of the hydro-electric power potential of the large northern rivers.

**Great Lakes-St. Lawrence Lowland**

Surrounding the Canadian Shield is a group of plains.

The plains are remnants of the sedimentary rock that once covered this area.

Rocks geologically similar to the Canadian Shield provide the base material.

The limestones, dolomites, sandstones, and shales that compose these lowlands and plains rest upon this base.

The most southerly of these plains is the Great Lakes-St. Lawrence Lowland.
It stretches from southwestern Ontario down the St. Lawrence Valley.

It also incorporates Anticosti Island and small parts of Newfoundland.

The rocks are generally horizontal.

Major relief is provided by the Niagara Escarpment, which is up to 100 metres high.

The only other major relief is provided by the Monteregion Hills, a series of granitic intrusions east of Montreal.

The rest of the terrain is covered by glacial deposits and is gently rolling, except for a large area consisting of eastern Ontario and western Quebec.

In eastern Ontario and western Quebec, deposition of sediments left by the former Champlain Sea produced an almost flat landscape.

An excellent soil has developed.

The excellent soil and relatively southern position have produced a prime agricultural area.

The agricultural area has been maintained largely because of its proximity to the main population centres.

**Interior Plains**

The region is gently rolling with elevation increasing in steps toward the West.

The most prominent topographic features are the northwest-southeast-trending escarpments and the associated large hills or plateaus.

The escarpments and associated large hills or plateaus define three levels.

The Manitoba Lowland is the lowest.

It is separated from the Saskatchewan Plains by the Manitoba Escarpment.

The Manitoba Escarpment is composed of large hills such as Riding Mountain.

The Saskatchewan Plains are the middle level.

The highest level is the Alberta Plain.
Within the Alberta Plain there are a number of large, isolated hills, such as the Cypress Hills.

The Cypress Hills area was high enough to remain unglaciated.

Glaciers left thick deposits of debris elsewhere.

Glacier debris developed into excellent soils that attracted nineteenth-century settlers.

Meltwater discharge during deglaciation cut large, deep valleys, called coulees, into the plain.

Glacial lakes in central Saskatchewan and southern Manitoba left relatively flat terrain when they drained.

Where pronounced erosion continues, badland topography has developed.

Pronounced erosion continues in the Drumheller area of Alberta.

The rocks that compose the Interior Plains were laid down in a warm, shallow sea.

Thus, the area is rich in coal, and especially oil and gas.

Saskatchewan, Manitoba, and British Columbia have some oil.

An area from Alberta northward to the Beaufort Sea contains most of the oil, as conventional deposits or oil sands.

The other primary mineral of the region is potash, mined in eastern Saskatchewan.

**Appalachian Region**

The Appalachian Region was formed during the collision of North America with Europe.

The Notre Dame Mountains, from the Eastern Townships of Quebec to the Gaspe Peninsula, are the highest remnants of the large mountains that have now been rounded by erosion.

Eastern New Brunswick, Prince Edward Island, and parts of western Nova Scotia consist of a gently rolling terrain.

Along New Brunswick’s Bay of Fundy coast, a series of hills about 450 metres high stretches toward western Cape Breton Island.
Between the series of hills and the upland along Nova Scotia’s east coast is the lowland area of the Annapolis Valley.

The Annapolis Valley extends to the plateau interior of Cape Breton.

In Newfoundland, the Long Range Mountains (800 metres) form the western side of the island while the remainder is an irregular plateau.

The area presented scattered lowlands suitable for agriculture.

Mineral resources reflect the complex geology.

Coal fields on Cape Breton Island support a steel industry.

Deposits of gypsum, potash, and lead/zinc are exploited.

The potential wealth of the Maritime region lies offshore in the oil fields of Hibernia and Terra Nova on the Grand Banks.

Potential wealth also lies offshore in the natural gas deposits of the Scotian Shelf.

The areas of potential wealth are the traditional fishing areas.

**Western Cordillera**

The Cordilleras of western North America were formed during the collision of the North American and Pacific plates.

This collision still continues—as those who live along the San Andreas fault will readily recognize.

Despite the complex topography and geology, the region can be subdivided into three parallel systems.

The Cordillera East section is composed of sedimentary rocks that have folded and faulted to produce a spectacular mountain chain.

In the south, the mountain chain is known as the Rockies.

It is known as the Mackenzie Mountains in the north.

Coal deposits located in the Cordillera East have been exploited since the late 1800’s.
The Cordillera West region includes the mountains of Vancouver and the Queen Charlotte Islands, the Coast Mountains on the mainland, and a trough between them.

These mountains are generally composed of igneous intrusions.

They reach altitudes of 4000 metres.

Between the two mountain belts lies the Cordillera Interior.

The Cordillera Interior is a mixture of mountains and high plateaus composed of igneous, metamorphic, and sedimentary rock.

Both the western and interior parts of the cordilleras are rich in the same types of minerals as are found on the Canadian Shield.

These include gold, silver, lead, and zinc.

They also include specialty metals such as tungsten and molybdenum.

APPENDIX F

INDEX OF GENERAL KNOWLEDGE OF CANADA

Please rate your knowledge of each of the following provinces and territories. Using the accompanying rating key, write the number (1 to 5) which best describes your knowledge level for each of the provinces and territories.

Newfoundland _____
Nova Scotia _____
New Brunswick _____
Prince Edward Island _____
Quebec _____
Ontario _____
Manitoba _____
Saskatchewan _____
Alberta _____
British Columbia _____
Yukon _____
Northwest Territories _____

Key for Rating Knowledge

1 --- I have very limited knowledge of the province or territory. I know the general location, and one or more cities.

2 --- I know some limited information about the province or territory. For example, I have sketchy knowledge of the resources, terrain, industry, climate of the province/territory.

3 --- I have detailed knowledge of the province/territory in at least one area, such as its geography, history, economics, culture, or people.

4 --- I have detailed knowledge of several areas related to this province/territory. This level of knowledge might correspond to someone who has lived in the province for several years, has travelled the province, and could describe the geography, resources, and industry to a visitor.

5 --- I have a wealth of knowledge related to this province/territory. I could lecture about the area, providing both descriptions and explanations of its geography, history, culture, and people.
APPENDIX G

PILOTING OF MATCHING TASK ITEMS

Pilot research was conducted in order to develop an associative-memory measure, a matching task, based on the information presented in the critical passage on Canadian physiography. The aim was to develop a task which included a more manageable subset of the information presented and which included factual information not previously known to the majority of students.

Subjects

The pilot sample consisted of 15 introductory psychology students (6 males and 9 females) who received bonus points toward their psychology grade in return for their participation in the pilot study.

Development of Matching Items

The critical passage presented information about 7 physiographic regions, which included: the Canadian Shield, the Great Lakes-St. Lawrence Lowland, the Interior Plains, the Appalachian region, the Western Cordillera, the Arctic Coastal Plain and Innuviation Region, and the Hudson Bay Lowland and Foxe Basin. For each region, individual facts were identified. For use in the matching task, each fact had to include sufficient information so that the fact could be identified as true for only one region. In addition, information about specific, readily identifiable locations, was excluded so that matching responses would not occur on the basis of location information alone. This was not always possible as information about topographic features of a region sometimes included names of identifiable locations or provinces. Using these criteria, 114 separate matching facts were identified.
Method

Students participated in a 1-hour session as part of a group testing session. These same students also participated in the initial piloting of the multiple-choice items. Prior to giving instructions in completion of the matching items, students were shown a map of the physiographic regions and the 7 regions were identified for them. Students were provided with this knowledge prior to completing the items as students studying the passage would be aware of the location of regions and it was important to determine which facts could be correctly matched with the region as a result of knowledge activated by knowing the location of the region. Next, students were randomly assigned one of two random orders of the 114 matching facts and received the following instructions:

You have before you a series of facts and a sheet listing the possible matching responses for each of these facts. The seven physiographic regions are listed and you should match each fact to the region for which it is true by using this list of regions and your knowledge about Canada. Please write your matching responses on the question sheet beside the fact. You may use short forms as long as your response is clear. Again, simply read each fact and mark your choice. You will have 30 minutes, which gives you about 15 seconds for each item. Thus, you will have to work steadily but you shouldn’t have to rush. Don’t labor over each item but it is important that you provide an answer for each item. Since you are attempting to match the items without reading the information on which they are based, don’t be discouraged or upset if you don’t know the answers. It is important that you provide an answer for each question.

Results

The probability of correct matching was calculated for each of the 114 items. If an item was answered with a probability of .50 or greater, it was considered that the majority of students already possessed knowledge of the fact. These items were not included in the final pool of items. Twenty-one items had probabilities of
correct matching of greater than .5 and were excluded. When piloting the experimental and control groups in another session, it became clear that the study passage was too lengthy and the passage was subsequently edited. This resulted in the removal of another 17 items from the pool of potential items for the matching-task. Therefore, the final pool consisted of 76 matching items. From this pool, 40 items were randomly selected for each region proportional to the quantity of text information presented for that region. Four random orders of item presentation were constructed with no more than two consecutive items from the same region.
APPENDIX H

MATCHING ITEMS

1. The region contains less than 10 percent of the population.

2. The region has little agriculturally useful land.

3. The region which resulted from the continental drift of at least seven micro-continents.

4. The region which originally consisted of mountains which have now been eroded away.

5. The region which has a relatively low, undulating terrain which may be quite rough in places.

6. One of the greatest elevations of this region is found along the eastern coast of Baffin Island.

7. The region which has precious metals which include gold, silver, and platinum.

8. The region which has iron, nickel, copper, lead, and zinc as utilitarian metals.

9. The region which has developed in the form of mining towns.

10. The region where most of the land is bare rock or has extremely thin soil.

11. The region where glacial depressions form lakes, ponds, or wetlands.

12. The region which contains the Abitibi clay plain, where substantial glacial deposits allow some farming.

13. The region where some farming is possible but where widespread, commercial agriculture is generally not feasible.

14. The region which has remnants of rock which once covered the Canadian Shield.

15. The region which has rocks that are generally horizontal.

16. The region where major relief is provided by the Montérégion Hills, a series of granitic intrusions.
17. The region where deposition of sediments by the former Champlain Sea produced an almost flat landscape.

18. The region has an excellent soil and a relatively southern position.

19. The region which is gently rolling with elevation increasing in steps toward the West.

20. The region which contains large hills such as Riding Mountain.

21. The region which has a plain with a number of large, isolated hills.

22. The region which contains the Cypress Hills which were high enough to remain unglaciated.

23. The region where thick glacial deposits resulted in excellent soil which attracted 19th century settlers.

24. The region where pronounced erosion continues, such as in the Drumheller area.

25. The region which is rich in coal, and especially oil and gas.

26. The region which contains oil either as conventional deposits or as oil sands.

27. The region which contains the Notre Dame Mountains, remnants of large mountains that have been rounded by erosion.

28. The Long Range Mountains (800 metres high) are in this region.

29. This region contains an island which is an irregular plateau with mountains on its western side.

30. The region has scattered lowlands which are suitable for agriculture.

31. The region has deposits of gypsum, potash, and lead/zinc.

32. The region's potential wealth lies offshore in oil fields of Hibernia and Terra Nova.

33. The region has potential wealth in the natural gas deposits of the Scotian shelf.

34. The oil and gas resources of this region lie in the traditional fishing areas.
35. The region was formed during the collision of the North American and Pacific plates.

36. The region contains an area composed of sedimentary rocks that have folded and faulted to produce mountains.

37. The region contains the Mackenzie mountains in the north.

38. The region contains mountains composed of igneous intrusions, reaching altitudes of 4000 metres.

39. The region contains a mixture of mountains and high plateaus composed of igneous, metamorphic, and sedimentary rock.

40. The region’s minerals include gold, silver, lead, zinc, tungsten, and molybdenum.
APPENDIX I

PILOTING OF MULTIPLE-CHOICE TEST ITEMS

The purpose of this piloting study was to develop factual and higher-level multiple-choice questions for use in the proposed study in assessing learning and comprehension of text content. Development of the multiple-choice items was guided by the results of student performance on the items over three different pilot study sessions. Development of factual versus higher-level multiple-choice questions was guided by the Taxonomy of Educational Objectives (Bloom et al., 1971). Factual questions were written to assess memory for information presented in the study passage and represented the "knowledge" level of the taxonomy. Higher-level questions were written to assess the comprehension level of the taxonomy. The comprehension level reflects understanding of the material as may be evidenced by the ability to paraphrase what the text has communicated, by the ability to take a different perspective on the material or understand in a new way by rearranging or reordering the content, or by the ability to understand the implications or consequences of the information presented (Bloom et al., 1971). Development of higher-level questions was guided by examples and principles of item-construction outlined by Anderson (1972) and Miller, Williams & Haladyna (1978).

Many authors have provided guidelines for the writing of good multiple-choice questions (Ellsworth, Dunnell & Duell, 1990; Mehrens & Lehmann, 1973; Miller et al., 1978), and these guidelines were followed when constructing the factual and higher-level MC questions. A MC question contains both a stem, which presents the question to be answered, and a list of possible answers. These possible answers
contain both the correct answer and incorrect responses which are meant to be
distracters (Mehrens & Lehmann, 1973). In writing the items, particular attention
was directed to state the problem in the stem so the question could be answered by
the student at the completion of reading the stem. As well, an effort was expended
to construct plausible distracters which would not provide clues to the correct
answer and which would not allow any distracter to be immediately discarded as a
possibility. The "best" answer format, which requires student to select the best
alternative to complete the stem, was used. For each question, four response-
alternatives were generated and care was taken so that the correct answer occurred in
each of the four positions with similar frequency.

Piloting Session 1

Subjects. Fifteen introductory psychology students (6 males, 9 females)
participated in a group testing session to pilot the initial set of multiple-choice items.
These students also participated in pilot testing of the matching items.

Materials. Thirty-six multiple-choice questions were developed using the
criteria outlined above. Twenty factual multiple choice (MC) questions were
constructed. Of these, 5 dealt with content related to the Canadian Shield, 3 dealt
with content related to the Great Lakes, 4 dealt with content related to the Interior
Plains, 1 dealt with content related to the Hudson Bay Lowland and Foxe Basin, 1
dealt with content related to the Innuition Region and Arctic Coastal Plain, 3 dealt
with content related to the Appalachian Region, and 2 dealt with content related to
the Western Cordillera. The frequency of factual items for each region was
proportional to the facts presented for each region in the text. Sixteen higher-level
questions were written. Each of the MC questions had four response alternatives and attempts were made to construct plausible distracters.

**Method.** Prior to giving instructions in completion of the multiple-choice items, students were shown a map of the physiographic regions and the 7 regions were identified for them. Students were provided with this knowledge prior to completing the items as students studying the passage would be aware of the location of regions and it was important to determine which MC questions could be answered as result of knowledge activated by knowing the location of the region. Students were then provided with one of two random orders of the MC questions and they received the following instructions:

You have before you some multiple-choice questions. Please read each question and the four response alternatives carefully. Try to do the questions in order. Simply give your best response and move on. You will have about 15 minutes to complete the questions; this should give you enough time to complete all the questions. Remember that you are answering without reading the text passage, so do not be concerned if you do not know the correct answer. Select the best alternative and if you don’t know the answer, make your best guess. It is important that you provide an answer for each item.

**Results**

The probability of a correct response was scored for each of the MC questions. As with the matching questions, any question answered with a probability of .50 or greater was excluded from further piloting as it was considered that such questions could be answered on the basis of prior knowledge or that the writing of the stem and alternatives had provided a clue as to the correct response. Six questions were associated with a probability of correct responding greater than .50. These questions included 3 factual MC and 3 higher-level MC items. The factual questions and
higher-level questions were either rewritten or replaced.

**Piloting session 2**

The purpose of this pilot study was to readminister the original and new multiple-choice questions to determine if any could be answered more than 50% of the time by students who had not read the study passage.

**Subjects.** Six introductory psychology students participated and received bonus point credit toward their introductory psychology grade.

**Materials.** The multiple-choice test consisted of a revised test of 37 MC questions, 21 factual questions and 16 higher-level questions. The six questionable items from the first pilot session were excluded and replaced with seven new questions. Three of the new items were simply rewrites of three of the problem items from the first pilot. The other four were new MC questions.

**Method.** Students were provided with 1 of 2 random orders of the MC questions and received the same instructions as for the first pilot session.

**Results.** Probability of correct responding was calculated for each of the MC items. None of the MC questions was answered correctly by more than half of the students. One item which included a negation in the stem was dropped from the question pool. Thus, the second revision of the items on the basis of this pilot session resulted in 36 MC questions (20 factual MC questions and 16 higher-level MC questions).

**Piloting session 3**

As a result of piloting the study passage and test questions with the experimental and control groups, it became clear that the study passage was too
lengthy. Editing of the study passage by removing certain text sections necessitated removing MC questions concerning that edited content. As well, the two regions eliminated from the passage had been used as distracters in many questions, requiring development of alternate distracters. The purpose of this final piloting session, was to evaluate the probability of correct responding with a greatly revised set of MC questions.

**Subjects.** The sample consisted of 15 introductory psychology students (1 male, 14 female) who received bonus point credit toward their psychology grade for participating in the half hour session.

**Materials.** The MC questions used in this pilot study were revised questions from pilot 2 as well as completely new questions developed for inclusion in this third pilot study. From the final 36 questions which resulted from pilot 2, only 9 were retained in the same form for pilot 3. Fourteen questions required the rewriting of the distracters as a result of editing the study passage. New and plausible distracters were developed by using incorrect answers supplied by the students for similar items presented in the piloting of the matching task. When no similar matching item occurred, the researcher constructed plausible distracters. Eight MC questions were rewritten to improve the stem or distracters and fifteen new items were constructed (9 factual MC questions and 6 higher-level MC questions). The final pool of items for piloting consisted of 37 MC questions (25 factual questions, 12 higher-level questions).

**Method.** Students were randomly assigned one of two random orders of the MC questions. Procedures and instructions were the same as for the first pilot study
of MC questions.

Results. As in the previous pilot studies of MC questions, the probability of correct responding was calculated for each of the items. Two items were answered correctly by more than 50% of the students. These questions were removed and a final version of the MC test was constructed. This final version consisted of 20 factual questions and 10 higher-level questions. In selecting the factual items, an attempt was made to represent each region proportionally to their representation in the study passage (Canadian Shield-6 questions; Great Lakes-3 questions; Interior Plains-5 questions; Appalachian Region-3 questions; Western Cordillera-3 questions). The final MC test is available in Appendix J.
APPENDIX J

MULTIPLE-CHOICE QUESTIONS

Factual Questions

1. The physiography of the Canadian Shield resulted from:
   a) the erosion of mountains
   b) the folding of igneous rock
   c) the activity of meltwater trapped by glaciers
   d) the erosion of shale and limestone to expose igneous rock

2. In which of the following regions does the Abitibi clay plain provide some agricultural land?
   a) Canadian Shield
   b) Western Cordillera
   c) Interior Plains
   d) Appalachian Region

3. Glacier activity in the Canadian Shield created:
   a) small depressions in the rock
   b) a gently rolling terrain which is covered by glacial deposits
   c) large, deep valleys or coulees
   d) a series of plateaus

4. One of the highest elevations in the Canadian Shield is:
   a) the Torngat Mountains
   b) the Long Range Mountains
   c) in the western area of Quebec
   d) in the western area of Baffin Island

5. The region formed as a result of the continental drift of 7 micro-continents is the:
   a) Canadian Shield
   b) Appalachian Region
   c) Western Cordillera
   d) Great Lakes-St. Lawrence Lowland
6. Which of the following regions is predominantly bare rock or has extremely thin soil:
   a) Canadian Shield
   b) Cordilleras
   c) Appalachian Region
   d) Interior Plains

7. Anticosti Island and small parts of Newfoundland are part of the:
   a) Great Lakes-St. Lawrence Lowland
   b) Canadian Shield
   c) Appalachian Region
   d) Annapolis valley

8. The Moncreregion hills are one of the highest points of the:
   a) Great Lakes-St. Lawrence Lowland
   b) Interior Plains
   c) Appalachian Region
   d) Canadian Shield

9. The topography of eastern Ontario and western Quebec was described as:
   a) an almost flat landscape
   b) gently rolling and covered by glacial deposits
   c) a series of granitic intrusions which provide major relief
   d) generally about 100 metres high

10. Deep valleys or coulees are characteristic of the:
    a) Interior Plains
    b) Appalachian Region
    c) Western Cordillera
    d) Great Lakes-St. Lawrence Lowland

11. Riding Mountain is:
    a) a large hill in the Manitoba Escarpment
    b) a large hill along the Bay of Fundy Coast
    c) part of the Coast Mountains of B.C.
    d) part of the Notre Dame Mountains
12. One area which was high enough to remain unglaciated was the Cypress Hills area of the:

   a) Interior Plains  
   b) Western Cordillera  
   c) Canadian Shield  
   d) Appalachian Region 

13. The highest level of the Interior Plains is the:

   a) Alberta Plain  
   b) Saskatchewan Plain  
   c) Manitoba Plain  
   d) Manitoba Escarpment 

14. Pronounced erosion has resulted in badland topography in which of the following regions:

   a) Interior Plains  
   b) Canadian Shield  
   c) Appalachian Region  
   d) Great Lakes-St. Lawrence Lowland 

15. The highest areas of the Appalachian Region are found:

   a) in the eastern townships of Quebec  
   b) on the eastern side of Newfoundland  
   c) in Nova Scotia along the Bay of Fundy coast  
   d) in eastern New Brunswick 

16. Which region has scattered lowlands which are suitable for agriculture?

   a) the Appalachian Region  
   b) the Great Lakes-St. Lawrence Lowland  
   c) the Interior Plains  
   d) the Cordillera East region of the Cordilleras 

17. A series of hills about 450 metres high occurs:

   a) along New Brunswick’s Bay of Fundy Coast  
   b) along the western side of Newfoundland  
   c) along the east coast of Nova Scotia  
   d) along the eastern side of Newfoundland
18. Which of the following statements best describes the mountains of the Cordillera West region of the Western Cordilleras? The mountains of the Cordillera West are:

a) composed of igneous intrusions  
b) rounded due to erosion  
c) a result of the continental drift of 7 micro-continents  
d) a result of the collision of North American and Asian plates

19. The mountain chain known as the Rockies (in the Cordillera East) was formed as a result of:

a) the folding and faulting of sedimentary rock  
b) the folding and faulting of igneous rock  
c) the folding and faulting of metamorphic rock  
d) the folding and faulting of both metamorphic and sedimentary rock

20. Which of the following regions contains the specialty metals--tungsten and molybdenum:

a) the Western Cordillera  
b) the Canadian Shield  
c) the Appalachian Region  
d) the Interior Plains

Higher-Level Questions

21. The topography of the Interior Plains may best be described as:

a) flat plains separated by a series of large hills, becoming quite hilly in the west  
b) northeast to southwest trending escarpments, with some flat areas and isolated hills  
c) a series of flat plains, with some rugged escarpments  
d) gently rolling with areas of flat terrain which have excellent soil

22. Which of the following statements best summarizes the bedrock geology which is associated with the formation of coal and oil deposits? Coal and oil results from:

a) trapped vegetation and aquatic life subjected to pressure  
b) the deposition of sedimentary rock which is subjected to pressure  
c) deposition of igneous rock which is subjected to high pressure  
d) the trapping of glacial debris in igneous rock
23. According to the text, which of the following events is most likely to result in development of level terrain?
   a) draining of a glacial lake
   b) deposition of debris by a glacier
   c) discharge of glacial meltwater
   d) ice scouring the surface of the land

24. The text stated that the Appalachian Region supports a steel industry due to the presence of a natural resource critical to the production of steel from iron ore deposits. Based on this reasoning, which of the following regions would be most likely to also support a steel industry?
   a) Western Cordillera
   b) Interior Plains
   c) Great Lakes-St. Lawrence Lowland
   d) Canadian Shield

25. Which of the following provinces lies completely within one physiographic region?
   a) New Brunswick
   b) Manitoba
   c) Quebec
   d) Newfoundland

26. If a company was interested in mining potash for use in producing fertilizer at a plant in Kingston, in which region are they most likely to purchase a mine? Consider ease of transportation in making your decision.
   a) Appalachian Region
   b) Canadian Shield
   c) Interior Plains
   d) Western Cordillera

27. Many regions have a particular resource(s) for which they are noted. Which region has the widest variety of resources?
   a) Appalachian Region
   b) Canadian Shield
   c) Interior Plains
   d) Western Cordillera
28. Based on the text's presentation of the effects of glacier activity on various regions, which region seems to have been the least affected by glaciation?

a) Western Cordillera  
b) Great Lakes-St. Lawrence Lowland  
c) Interior Plains  
d) Canadian Shield

29. The Hudson Bay Lowland borders the Canadian Shield and the southern shore of Hudson Bay. Of what type of rock would you expect this region to consist?

a) sedimentary  
b) igneous  
c) metamorphic  
d) both metamorphic and igneous

30. Given similar amounts of heavy rainfall, which of the following areas would be the most likely target for widespread flooding?

a) southern Manitoba  
b) eastern Alberta  
c) western Saskatchewan  
d) Gaspe peninsula of Quebec
APPENDIX K

CONSENT FORM

Educational researchers have been interested in the relationship between students’ approaches to studying and their learning of new information. The current study is part of continuing research which investigates the relationship between students’ processing of information during study and learning.

If you agree to participate in the research project, you will participate in a 1.5 hour session and will receive 2 experimental credits. All information collected will be kept confidential as you will be assigned a number and only this number will identify your data. It will not be possible for the experimenter or anyone else to connect any information with your name. Personal information such as your gender, age, number of years spent in Canada will be recorded. This information is needed to provide a general description of the participants in the study in a final research report. In addition, you will be asked to complete a rating form which provides some information about you familiarity with Canada and with certain concepts in the text you will be studying. You are free to refuse to answer any items. You will be presented with and asked to study a text passage, such as you might be asked to study for a course. Following study, you will be asked to complete multiple-choice and matching tests on the material you studied. Some of your responding during the session will be tape-recorded for later analysis. It is important to remember that your performance during the session represents only your performance under the experimental conditions and does not represent what you could accomplish under different conditions. All information collected is for the purposes outlined for the present research only. Your participation is strictly voluntary and you may withdraw at any time without penalty. If you have any complaint about the conduct of the research, you may contact Dr. R. Frisch, chairperson of the Psychology Department Ethics Committee (253-4232, ext. 7012).

If you wish to receive a final summary of the results of the experiment, which should be available in the summer of 1993, please leave your name and permanent mailing address in the envelope outside the experimenter’s lab.

Vicky L. Martin, M.A.  Akira Kobasigawa, Ph.D.
Doctoral Candidate  Professor
Department of Psychology  Department of Psychology
VITA AUCTORIS

<table>
<thead>
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