CANADIAN THESES

THÈSES CANADIENNES

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30.

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30.

THIS DISSERTATION HAS BEEN MICROFILMED EXACTLY AS RECEIVED

LA THÈSE A ÉTÉ MICROFILMÉE TELLE QUE NOUS L'AVONS REÇUE

The Effects of Detached and Embedded Learning Strategies on the Processing of Illustrations in a Self-Instructional Unit

Susan E.M. Gram

A Thesis

In

The Department

of

Education

Presented in Partial Fulfillment of the Requirements
for the Degree of Master of Arts
Concordia University
Montréal, Québec, Canada

September 1987

ISBN 0-315-37075-0

ABSTRACT

The Effects of Detached and Embedded Learning Strategies on the Processing of Illustrations in a Self-Instructional Unit

Susan E.M. Gram

Although extensive research has been conducted to determine the effects of pictures in instructional texts, few have proven successful in demonstrating a consistent positive effect for pictures or isolating the critical elements of illustrations to serve as guidelines for effective instructional design.

The purpose of this two-part study was to examine the effects of two distinct types of learning strategies -- identified herein as "detached" and "embedded" -- on the processing of the both spatial and sequential information contained in illustrations in a modified self-instructional unit entitled "The Nature of Pain."

The first part of the study consisted of three learning strategies (general, embedded, detached) in a 2 x 2 x 2 factorial design. One hundred and fifteen subjects participated in intact groups as part of their required coursework. Results showed that there was a significant effect for the Embedded Strategy which interacted with Reading Level in all conditions. Further examination of the results revealed that the Embedded Strategy was significant for Picture Items Only on the criterion measures. Therefore, a second study was conducted to examine these differences.

In the second part, the experimental design was modified to include two No-Picture conditions. One hundred and forty-three subjects participated in intact classes. Results showed that there was a significant interaction of both embedded

and detached strategies for Picture Items Only. Post hoc comparisons suggested that the illustrations contained unique information for the learner.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Even with the recent explosion of computer and video technology within education, print-based instructional material is still the most common vehicle for the transmission of information. Perhaps it is our day-to-day familiarity with the medium which underscores its importance in the instructional process. Textbooks dominate every classroom from the first grade to university level courses. Often, the curriculum itself is developed with a specific textbook in mind, making it difficult to know which decision determined which: does the design of the curriculum determine the choice of textbook, or does the textbook determine the design of the curriculum?

Due to the proliferation of the written word as the primary mode of transmission in the instructional setting, it is mandatory that educational technologists examine, in a systematic manner, the variables which contribute to the success of certain materials. Rather than leaving the designers of texts to create educational materials based primarily on intuition, it is necessary for educational technologists to apply a precise methodology for gathering accurate data from which they can develop practical guidelines to produce effective materials.

This attitude applies also to the role of illustrations which are a significant part of modern textbooks. That most educational textbooks include illustrations is taken for granted today, although little is known about how effective they are in promoting the learning objectives of the material.

Although extensive research has been conducted to determine the effects of pictures in instructional texts, few studies have succeeded in demonstrating a consistent positive effect for the use of pictures nor have they isolated the

critical elements of effective illustrations to serve as guidelines for instructional designers. This may be due in part to the diverse nature of pictures themselves, which range from bright, colourful illustrations in reading primers to highly-detailed diagrams in technical manuals.

Another factor which may have contributed substantially to the lack of generalizable results in this area is the research design methodology employed in the majority of studies. Many diverse approaches have characterized early research into the effects of illustrations on learning from textual materials. The paradigm of gross comparisons has tended to dominate the field (Levie and Lentz, 1982). Abandoning this picture/no-picture, all-or-nothing research approach for the functionalist approach of Duchastel (1980), researchers have still failed to identify effective guidelines for the design of pictures which would ensure the mastery of specific educational objectives. Although the classification of pictures according to function as opposed to form has aided educators in the selection of appropriate illustrations to accompany instructional texts, this approach has done little to control the myriad personality characteristics, learning strategies, and individual motivations the learner brought to the instructional situation. Aptitude-treatment interaction research (Cronbach and Snow, 1979), in which an attempt is made to match the components of the learning package (i.e. pictures) to the individual characteristics of the learner, represents another possible approach to effective textual design. But even if it were possible to identify a predictable relationship between cognitive abilities and learning tasks, it would not be economically feasible to produce the necessary variety of materials to suit each individual learner.

In contrast to these approaches, this study employed two different forms of general learning strategies termed "detached" and "embedded" from the learning strategies curricula developed by Rigney (1978). They were included to provoke

the learner to use the illustrations in a manner which reflected the purposes for which they were designed and to derive the unique information contained within.

In order to create effective strategies which will serve to enhance a subject's retention of content presented in an illustration, it is first necessary to examine alternate models of cognitive processing: the Dual-Coding theory of Paivio (1971) and the Propositional theory of Anderson and Bower (1973) and Pylyshyn (1973).

Paivio's Dual-Coding theory states that individuals do not simply encode information in the same form it is transmitted (i.e., pictorial encoded imaginally and linguistic encoded verbally). Rather, all messages are encoded in parallel with serial concepts retained linguistically and spatial information coded imaginally. Propositional theory, on the other hand, purports that individuals cognitively process all information to a deeper semantic level where information can be translated into any other form while retaining its core truth value. It is this concept which forms the basis for the embedded strategies included in this design.

Therefore, the purpose of this two-part experiment was to examine the effects of two distinct types of learning strategies -- identified herein as "detached" and "embedded" -- on the processing of both spatial and sequential information contained in illustrations in a modified self-instructional unit entitled "The Nature of Pain." More specifically, the first experiment was an attempt to demonstrate that in order for pictures to be effective as instructional aids, the learner must be made aware of the purpose of the illustrations, the information they contain, and how to process it effectively. The second experiment of the study was a replication of the first study with a few modifications. It included two control conditions which attempted to clarify the role of pictures in the initial experiment.

CHAPTER 2

REVIEW OF THE LITERATURE

Picture-Prose Research

Picture-prose research has in the past been subject to a number of divergent approaches in research design. It is, therefore, necessary to examine each of the major paradigms in terms of their efficacy for revealing the effects of illustrations in instructional materials in order to determine the appropriate one for the present research design.

The All-Or-Nothing Paradigm

As in most areas of educational research, one of the first questions to be addressed in the area of picture and prose research was couched in the traditional all-or-nothing paradigm:

> "Do individuals comprehend textual material better if pictures are included?"

This type of research traditionally compared two treatment conditions: one in which a particular factor is present to one in which the same factor is absent (Brody, 1981). Studies in this vein were most common using the "plastic" media (such as television, film and slide-tape). The all-or-nothing approach assumed that it was the unique form of presentation via different media, and not the intra-medium differences, which accounted for any potentially significant effects. Unfortunately, most studies of such gross comparisons, whether they employed sophisticated electronic media or simple illustrations in print material, failed to show any significant differences in either the comprehension or retention of

subject matter (Levie and Lentz, 1982). That is not to say that there were no measurable effects attributable to the differences in mode of transmission, but that such comparisons failed to reveal any generalizable results. Within the area of picture-prose research, critical issues such as the learning of illustrated vs. non-illustrated information, the construction of effective criterion measures for visual learning and the investigation of the possible long-term effects of illustrations on memory were confounded by such inadequate research design. A total reconceptualization of the substantive question became necessary.

Typology of Morphology

In pursuit of an intra-medium approach to the question of pictures and prose, the next development in research methodology was an attempt to delineate specific characteristics of pictures (Fleming, 1967) in order to construct a typology based on those characteristics, and then to demonstrate differential effects attributable to this rigid classification scheme. But, just as in other media research, the task of identifying discrete characteristics with which to describe and classify pictures proved illusive. The nature of illustrations -- whether photographic or graphic, realistic or abstract, colour or black-and-white -- failed to yield an easily-constructed taxonomy. The diversity of the elements which make a picture -- in fact, the definition of those very elements, their possible combinations, the lack of objectified standards -- all contributed to the failure of researchers to manipulate so-called extreme (i.e. dichotomous) variation and, as a result, produce a measurable effect in contrasting treatment conditions (Dwyer, 1978). A typology based on morphology did not provide an effective foundation from which to create effective research designs. A new approach was still needed. Although the typology of morphology approach was an improvement on the all-or-nothing paradigm, it still failed to produce results

because of the amorphous nature of illustrations. But it did suggest the notion of classification which would eventually prove useful.

Typology of Function

As an alternate means of classifying illustrations to Fleming's typology of morphology, Duchastel (1980) introduced the concept of function to the area of picture-prose research. He proposed three main functions for pictures: (1) attentional; (2) explicative; and (3) retentional.

The attentional role is one that is most familiar in our visual environment. Pictures that attract, that catch the eye, that move someone to examine a given book or magazine -- all are pictures demonstrating the attentional function. Magazines, billboards, television commercials, and books all incorporate visually-appealing images to entice the viewer to take note of their messages. That certain images are more effective than others in attracting our attention has been the foundation of Madison Avenue for many years, although research studies that have examined this issue are virtually non-existent (Duchastel, 1980). Modern textbooks continue to include a vast array of appealing images -- sometimes at great cost to the user -- without any evidence that such additions enhance learning outcomes. Colour, implied motion, the viewer's emotional state, the intent of the publisher, all these and many other intangible factors can contribute to a successful picture. Its success is as dependent on the designer as on the viewer as on the incidental features of the viewing environment at any given moment. A common example of this intuitive use of illustrations is the pictorial content of most basal reader series.

Explication is the second function Duchastel identified. Illustrations designed with this purpose in mind depict something (i.e., a process, a detail, an aspect) that cannot be clearly expressed in words. A famous incident in art

history can serve to demonstrate this point: the German artist Albrecht Durer (Gombrich, 1960) produced a woodcut of a rhinoceros based on a written description of the exotic animal by a contemporary. Unfortunately, the finished product resembled more a horned cow in a suit of armour than it did a rhinoceros. The verbal description had failed to communicate to Durer what a photograph or a casual glimpse would have demonstrated easily. So, too, in educational illustrations, there are those topics or concepts that are optimally presented in a visual manner.

Within the explicatory function, certain characteristics pertaining to specific content areas have proven through research to be generalizable: the degree of realism necessary to be most effective, the use of colour to highlight salient features, and the amount of detail necessary to maximize their explanatory effectiveness. These characteristics have been described by Dwyer (1978) in his exhaustive research studies.

This list of explicatory functions has since been expanded to include sub-purposes such as descriptive, expressive, constructional, functional, logico-mathematical, algorithmic, and data display. Illustrations which are most often encountered in instructional texts are examples of these specific informational functions: graphs, exploded-diagrams, photographs, algorithms, etc. (Duchastel and Waller, 1979)

The third and final function cited by Duchastel is retentional. In this role, illustrations serve to increase retention or memory for details and/or concepts presented in the accompanying text. The purpose of the picture is not simply mnemonic as was the case in classic paired-associate research where lists of words stored in conjunction with an image can be remembered more easily than word lists by themselves. (This type of study is limited in its application to the educational setting due to the artificiality of the assigned tasks.) Rather, the

retentional function includes illustrations which are associated with a set of concepts contained in a textual passage and which may aid in the recall of detailed information in the passage.

Duchastel (1981) conducted one of the few ecologically-valid studies in which the effects of pictures (illustrated passage vs. non-illustrated passage) on retention of main ideas and detail were measured over time. Results showed a significant interaction of pictures and prose on the delayed measure. Although the results were limited, they did offer some support for the hypothesis of the retentional function. In his discussion, Duchastel suggested that it may have been the ambiguous role of the illustrations (both attentional and retentional) that caused the less-than-conclusive results.

In order to understand the full implications of such results, it is first necessary to discuss some of the theoretical underpinnings of picture-prose research.

Imagery Theory

Just as there have been many approaches to research into pictures and prose, a number of diverse theories have been proposed to explain how an individual cognitively processes pictorial information. The various theories of imagery have important implications for the discussion of illustrations and their potential effects on learning and memory. The two major theories, the first proposed by Paivio and the other by Anderson, Bower and Pylyshyn, will be considered here:

a) Paivio's Dual-Coding Theory

In recent years, many have taken Paivio's (1971) Dual-Coding theory, which states that there exist two parallel mechanisms by which we remember

information -- a verbal one and an imaginal one (Anderson, 1978) -- to mean that pictorial information is stored imaginally and verbal information linguistically. The arguments surrounding Imagery theory reflect this simplistic assumption (Winn, 1982). It is argued, based on Paivio's theory, that since pictures can increase the amount and the efficiency of the retentional process, they should be included in all teaching material. Learners would then be encouraged to process any relevant pictures in order to later retrieve the salient information. This approach is similar to the pedagogical mis-applications of Piaget where developmental levels of cognitive abilities became prerequisites to specific educational activities.

Paivio's Dual-Coding theory does not support the notion that what is presented imaginally will be retained imaginally. He proposed, instead, a theory which stated that information is coded both verbally and imaginally. Contrary to what many assumed, there exists no easy one-to-one correspondence between type of coding and the form of the actual transmission --i.e. words stored verbally, pictures stored imaginally. But rather, information is stored in its most appropriate form. Linguistic coding is used to code serial information while imaginal processing codes spatial information. These systems are thought to operate in parallel and differentially from individual to individual. Depending on the type of information contained in the image, it may be stored either linguistically or imaginally or both. If it is the spatial characteristics of the display that are the salient features to be remembered, then this application may hold true. But simply supplying visuals to text is no guarantee of improved retention of textual information.

b) Propositional Theory

The other major theory put forth by Anderson and Bower (1973) and

Pylyshyn (1973) among others is known as Propositional. The major innovation in this cognitive information-processing model is the conceptualization of another level of meaning which underlies the verbal and imaginal coding of Paivio -- the propositional. The "proposition" is the core of information of any display which captures the relationship among the concepts, whether coded verbally or imaginally, and the truth value of the information. In other words, it is the meaning beyond the form of the message -- the semantic reality -- which can be translated or transformed from one code to the other and back again (Anderson, 1978).

The limitation of such theorizing is that the mechanisms of cognition described by Anderson and Bower (1973) and Pylyshyn (1973) are really the product of introspection, not readily available for inspection and, therefore, limited in their usefulness. Such theories, though, do serve to provoke new views on how we come to process information about our environment and ultimately may lead to innovative educational practices.

But if the presence of pictures cannot be shown conclusively to be more effective than the absence of pictures in comprehending textual information; if the most effective types of pictures or even those elements of pictures which can guarantee desired outcomes cannot be isolated; and if there is no certainty as to whether a picture is appropriate to its chosen purpose in terms of an acceptable cognitive processing model, then what can responsible instructional designers do to maximize the effectiveness of their carefully-designed and selected illustrations?

The approach examined in this study was that designers should employ explicit as well as implicit means to provoke the individual to use the picture in the manner for which it was designed. To accomplish this, it was decided that learner strategies should be included that would ensure the fulfillment of those

objectives within the instructional material.

Learner Characteristics

When learner characteristics are incorporated into the design of instructional materials, a number of approaches can be employed. Two of the most popular are considered below: Aptitude-Treatment Interaction (Cronbach and Snow, 1979) and Learning Strategies (Rigney, 1978).

a) Aptitude-Treatment Interaction

In recent years, Aptitude-Treatment Interaction (ATI) research has become popular in the development of effective instructional materials. One of the major tenents of an ATI approach is that materials should be designed to match the task-related characteristics of the learner population. This necessitates the initial identification of specific skills of the individual learner which may influence their performance of a given learning task. The next stage is the development of materials which will compensate for any lack of this skill one individual learner may exhibit while avoiding penalizing the high ability of another learner (Winer & Schmid, 1986).

Unfortunately, the ability to extract information from illustrations does not lend itself to any standardized measure. As was stated earlier, it is not possible to externally measure how a person deciphers a picture, how they encode the salient features (either sequentially or spatially) or how it is retrieved from memory. At this point in picture-prose research, it is not possible to identify a specific learner characteristic or set of characteristics to match a given piece of illustrated material to ensure retention of the concepts presented.

The need for a more general means of achieving the desired learner outcomes led to development of a learning strategies-based curriculum.

b) Learning Strategies

The focus in the educational research arena has recently shifted from improvement of "teaching" to the improvement of "learning." This perspective is especially evident in individualized instruction and, more recently, computer-assisted learning. The educational model based on this perspective calls for the individual learner to bring an effective set of cognitive skills to the task or for the medium or transmission to capitalize on the learner's own style of learning in order to attain the stated educational goals. This approach has resulted in renewed theoretical interest in how we learn and how we "learn to learn" culminating in new learning strategy curriculums, including training in mneumonics, visualization, analogies questions, SQR3 (Robinson, 1946) and inventories assessing individual learning styles (Dahsereau, 1978).

Rigney (1978) has identified two categories of learning strategies -- system-assigned and student-assigned. The term "system-assigned" refers to strategies that are externally facilitated within the instructional material itself by cueing the learner to activate and apply the appropriate learning strategy where necessary. System-assigned strategies are contrasted with student-assigned strategies -- those strategies that individuals apply to a learning situation without explicit provocation. These, of course, are somewhat outside the direct control of the instructional designer and, therefore, were not the focus of this investigation. For the purposes of this study only, one type of learning strategy was investigated -- the system-assigned strategy.

These two broad categories can each be sub-divided into two levels of explicitness -- detached and embedded (see Figure 1) (Rigney, 1978).

Explicitness of Cognitive Strategy	Control of Orienting Task	
	System-Assigned	Student-Assigned
Detached	A	C
Embedded	B	D

Figure 1. Rigney's typology of cognitive strategies (1978)

A "detached" cognitive strategy is one that is presented independently of the subject matter. Instructions for the learner to use analogies or to employ mneumonics would be an example of a detached strategy. An "embedded" cognitive strategy is not explicitly defined independent of the material. In fact, the learner must use the particular processing resource to accomplish the task. Questions which force the student to process the information at a deeper semantic level would be an example of an embedded strategy (Rigney, 1978).

The present study focused only on the two combinations of system-assigned detached (labelled "A") and embedded (labelled "B") strategies (see Figure 1). The assumptions underlying such an approach were that a learner could be trained to employ successful strategies within the instructional unit and that these skills would generalize to other instructional situations.

As in many ATI studies, such a manipulation is hypothesized to benefit low-ability persons while having little, if any, detrimental effect on those of high ability (Bovy, 1982). Dean and Kulhavy (1981) studied the effects of labelling strategies in a map-learning task. The results showed an effect for modelling successful strategies, with low verbal ability students benefitting the most.

Winn (1982) has attempted an application of these concepts to the effective

processing of illustrations. In his research, subjects had to identify the pattern and sequence of letters projected in random locations on a computer screen. The strategy taught to the learners was to record the pattern or sequence on a piece of paper. The group which received both training in the task and precueing to perform that task out-performed all other groups. Again, there was an ATI effect for modelling the strategy. Unfortunately, the artificiality of the task limits the real-world application of such results. This lack of generalizability prompted the application of these strategies to the realistic instructional materials employed in the present study.

The initial stage of the study sought to apply the concepts of detached and embedded strategies of the processing of non-redundant illustrated information to a more ecologially-valid instructional situation. Due to the limitations of a one-shot empirical study, there was no opportunity for providing training in an actual learning strategy. What was attempted was the provocation of ordinary approaches to deciphering pictures assumed to be part of most first-year college students' learning repertoires.

Statement of the Problem for Experiment One

The study attempted to answer the following questions:

1. Would the inclusion of a detached learning strategy prior to an illustration facilitate the processing of the unique information contained therein?
2. Would the inclusion of an embedded learning strategy following an illustration facilitate the processing of unique information contained therein?
3. Would there be a significant facilitative interactive effect for the inclusion of both detached and embedded learning strategies on the processing of information contained in the illustrations?

CHAPTER 3

EXPERIMENT ONE

Subjects

Subjects were one hundred and fifteen college students from Algonquin College in Ottawa. They participated in intact groups as part of the required English component in their programme of study (i.e., Technical, Hotel Management, or Business). The sizes of the classes varied from four to fifty students. The sample consisted of an equal number of males and females.

Design

The study consisted of a 2 x 2 x 2 factorial design. The three factors were the inclusion (or exclusion) of three different learning strategies: General Strategy, Detached Strategy and Embedded Strategy. All were between-group comparisons (see Figure 2).

Materials

Passage. The passage used in the study was derived from a self-instructional unit developed by the author entitled "The Nature of Pain." The topic was selected because it had a strong visual component and was sufficiently related to the prospective sample of student nurses to allow the variable of prior knowledge to be included. (But as the design indicates, this variable was ultimately rejected due to the loss of the initial sample in Montreal.)

The content was based on a selection of books and articles on pain (Melzack, 1966). The unit was submitted and approved without revisions by Dr. R. Catchlove of the Royal Victoria Hospital's Pain Management Unit in Montreal (see Appendix).

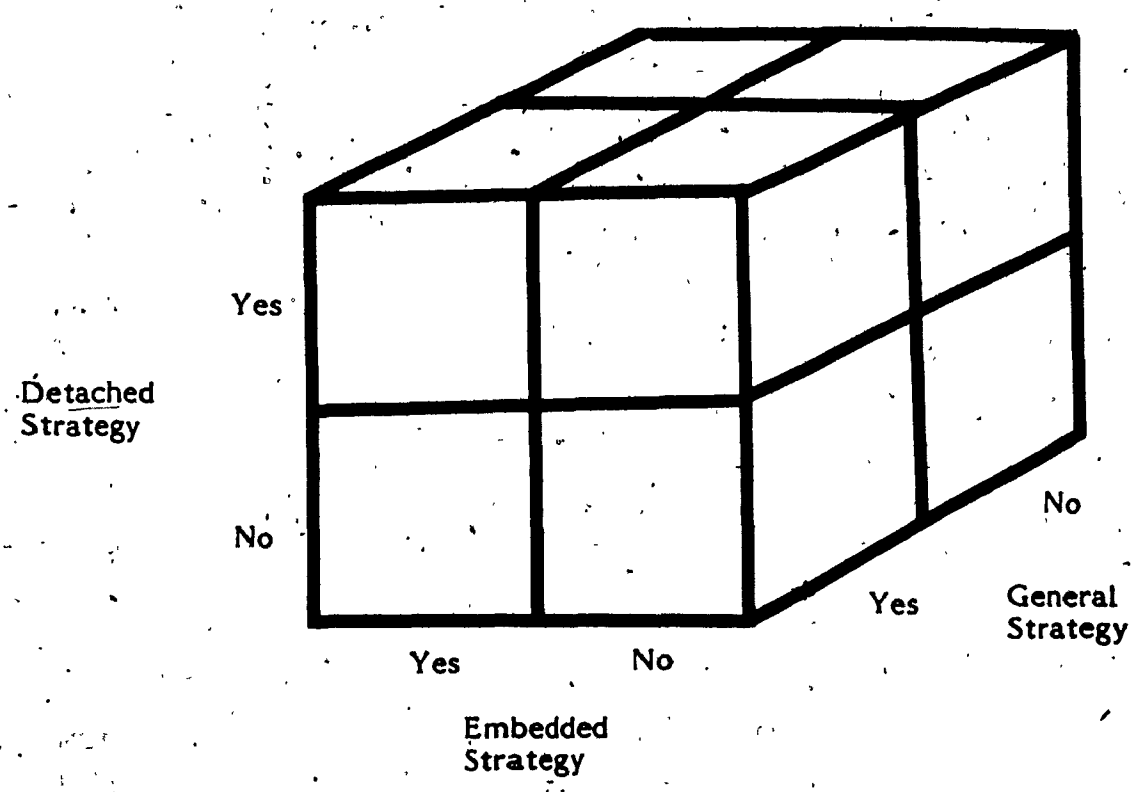


Figure 2: Design for Experiment One involving three learning strategies: General, Detached and Embedded.

Learning Strategies. The inclusion of learning strategies was operationalized as additional textual paragraphs which were to provoke additional processing of information contained in the illustrations. The three strategies were labelled General, Detached and Embedded according to their function (see Appendix). A more complete description follows:

A. General Strategy condition: In the General Strategy condition, a unique set of instructions was included at (or excluded from) the beginning of the experimental passage. It explicitly stated that the information contained in the illustrations that accompanied the passage was as important as the information contained in the text. In other words, the student was advised to take special care when examining the pictures.

B. Detached Strategy condition: The detached strategy condition consisted of a series of four embedded paragraphs, each of which appeared within the text just prior to the relevant illustration (of which there were four). These paragraphs simply directed the reader's attention to the picture which followed. They also indicated the special feature of the illustration to be noted.

C. Embedded Strategy condition: The format of the embedded strategy condition was similar to that of the detached strategy except that the paragraphs were positioned after each illustration. The embedded strategy paragraphs were much more detailed than the detached strategy in that they guided the reader step-by-step through the significant features of the illustrations and highlighted the critical relationships among them.

Illustrations. Four different illustrations designed by the author were contained in all four conditions. The first and second pictures were modifications and/or simplifications of actual diagrams found in medical textbooks. (The modifications were necessary to eliminate any extraneous information contained

in the diagram.) The third diagram was modelled after Holliday's (1977) realistic charts of weather cycles in that the cyclic nature of the concept "The Cycle of Pain" was represented diagrammatically. The final illustration was a summative chart, common to most textbooks, which served to compare and contrast the characteristics of the three types of pain in an economical fashion. All four illustrations appeared in all experimental conditions.

Instrumentation. A 25-item multiple choice test was constructed by the author. Each multiple choice question consisted of a main stem with five options which included only one correct choice. The test consisted of 13 picture-based questions and 12 text-based questions (see Appendix).

Free recall was used as a second dependent measure in Experiment One. After studying the passage, the students were instructed to write down as much as they could remember from the unit. But subject response to such a task was clearly aversive to the observers and the results were deemed inconclusive and dropped from the analysis.

A 16-item Likert scale questionnaire was developed which attempted to measure subjects' reactions to the picture-based questions in the multiple choice test (see Appendix).

Also, the Nelson-Denny Reading Test was administered to all groups prior to the main experiment. The reading scores were treated as a covariate in the analysis.

Procedure

The experimental materials were administered to eight intact groups during a two-hour regularly scheduled English class. Due to the fact that the groups were intact and of unequal size, and therefore not amenable to random subject

assignment, the materials themselves were randomly distributed. All sections of the experimental procedure were monitored and timed by the researcher and the assistant. After the Nelson-Denny Reading Test was completed (22-1/2 minutes cut-rate administration for adults), the subjects were directed to read and study the experimental passage for twenty minutes. An interpolated task -- a math quiz -- was assigned for the next two minutes. The subjects then were instructed to write down as much about the passage as they remembered. They were then directed to complete the multiple choice questionnaire at their own pace. The experiment was concluded with the attitude questionnaire. Subjects were allowed to leave the testing area after they had completed all of the above tasks.

Results of Experiment One

The scores on the multiple choice test were analyzed using an analysis of variance which assessed the effects of the general strategy, the detached strategy and the embedded strategy. There was no significant three-way interaction. Therefore, an analysis of main effects was pursued.

General strategy. It was found that there were no main effects for the General strategy (F (1,107) = .52, p = .47). Due to the assessed weakness of the General strategy as a contributing factor, it was dropped from further analyses.

Detached and Embedded Strategies. Due to the differences in reading ability between groups, the subjects were divided into three groups designated as High, Medium and Low using their scores on the Nelson-Denny Reading Test. Reading ability then was used as a blocking variable and the design was analyzed using a 2 x 2 x 3 (detached strategy x embedded strategy x reading level) analysis of variance (see Figure 3).

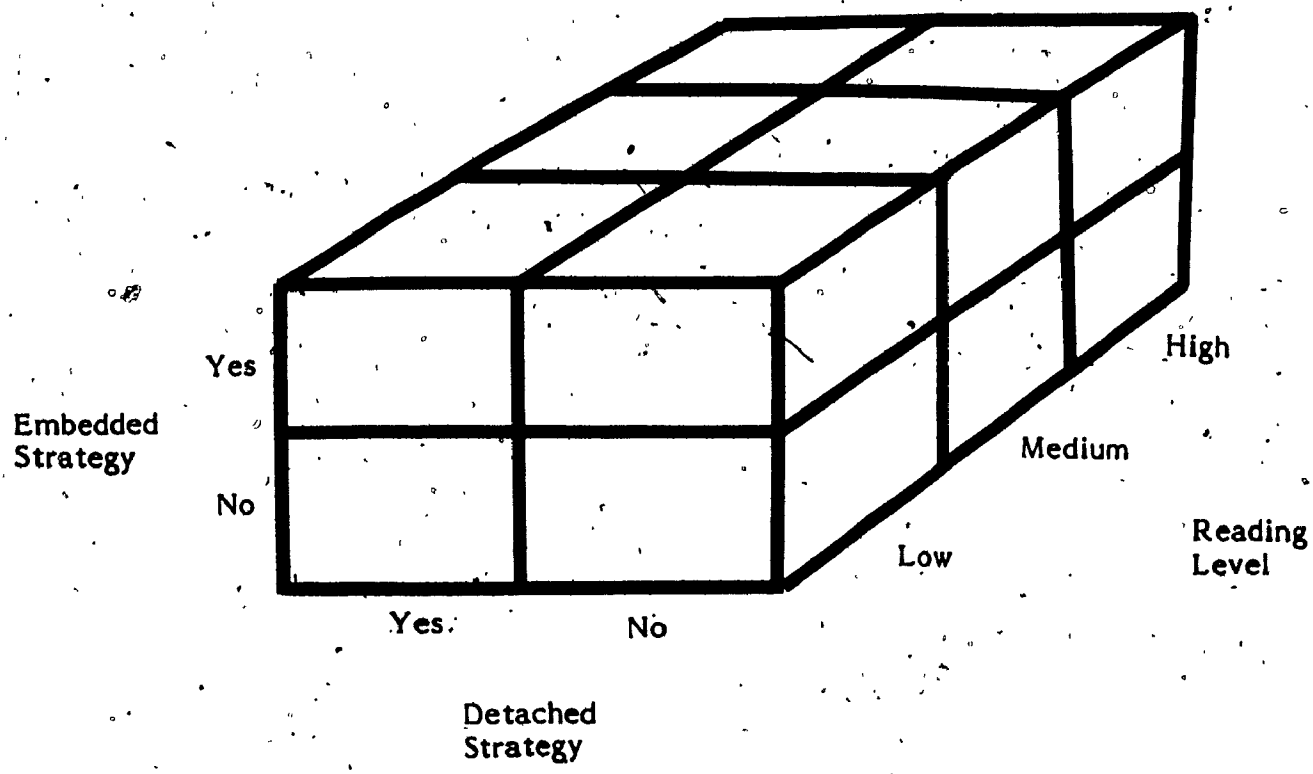


Figure 3: Revised design for Experiment One with Reading Level included as a blocking variable.

Table 1

Cell Means of Posttest Scores (Total) for Experiment One

	Detached Strategy	No Detached Strategy
Reading Level - Low		
Embedded Strategy	8.30	6.54
No Embedded Strategy	6.63	7.88
Reading Level - Medium		
Embedded Strategy	10.92	10.00
No Embedded Strategy	8.36	8.10
Reading Level - High		
Embedded Strategy	11.00	12.37
No Embedded Strategy	11.62	9.67

This analysis of the Posttest scores (total) produced significant main effects for Embedded strategy (F (1,114) = 4.93, $p < .05$) and Reading Level (F (2,114) = 15.94, $p = .001$) (see Table 2).

Examination of the three-way analysis on the Posttest (Picture items only) showed consistent results (see Table 3). The Embedded Strategy had a significant (F (1,114) = 11.64, $p = .001$) positive effect on test scores for picture items. This was also true for Reading level (F (2,114) = 3.76, $p < .05$) (see Figure 4).

Free Recall. As was stated earlier, the lack of student response to this criterion measure necessitated excluding the free recall measure from the analysis.

Discussion

The overall results of Experiment One showed that there was a significant effect for the Embedded Strategy which interacted with Reading Level in all conditions.

Reading ability as measured by the Nelson-Denny Reading test was a significant factor in subjects' Posttest Scores (Total). This reflects perhaps the diversity in reading ability of the community college level students. As the students were drawn from a large number of classes and from a variety of academic areas such as hotel management and cabinet-making, it can be inferred that these groups differ on a number of measures. Some areas of study require a higher degree of academic ability than others. It is possible that such differences are used for placement by the college's admissions office, or indeed, the students themselves are self-selecting: students with average reading ability choosing the more academic areas requiring essay-writing and extensive reading and those with below average reading skills opting for the more technical/manual programs

Table 2

Results of Analysis of Variance for Posttest Scores (Total)

Source of Variation	SS	df	MS	F	
Detached (A)	7.886	1	7.886	.90	
Embedded (B)	43.190	1	43.190	4.93	*
Reading Level (C)	279.335	2	137.667	15.93	**
A X B	.681	1	.681	.08	
B X C	23.475	2	11.738	1.34	
A X C	.123	2	.061	.01	
A X B X C	43.756	2	21.878	2.5	
Error	902.862	103	8.766		

* $p < .05$

** $p = .001$

Table 3

Results of Analysis of Variance for Posttest (Picture Items Only)

Source of Variation	SS	df	MS	F	
Detached (A)	5.48	1	5.48	1.32	
Embedded (B)	48.45	1	48.45	11.64	*
Reading (C)	31.31	2	15.66	3.76	**
A X B	9.24	1	9.24	2.22	
B X C	10.65	2	5.33	1.28	
A X C	1.49	2	.75	.18	
A X B X C	18.13	2	9.07	2.18	
Error	428.69	103			

* $p = .001$

** $p < .05$

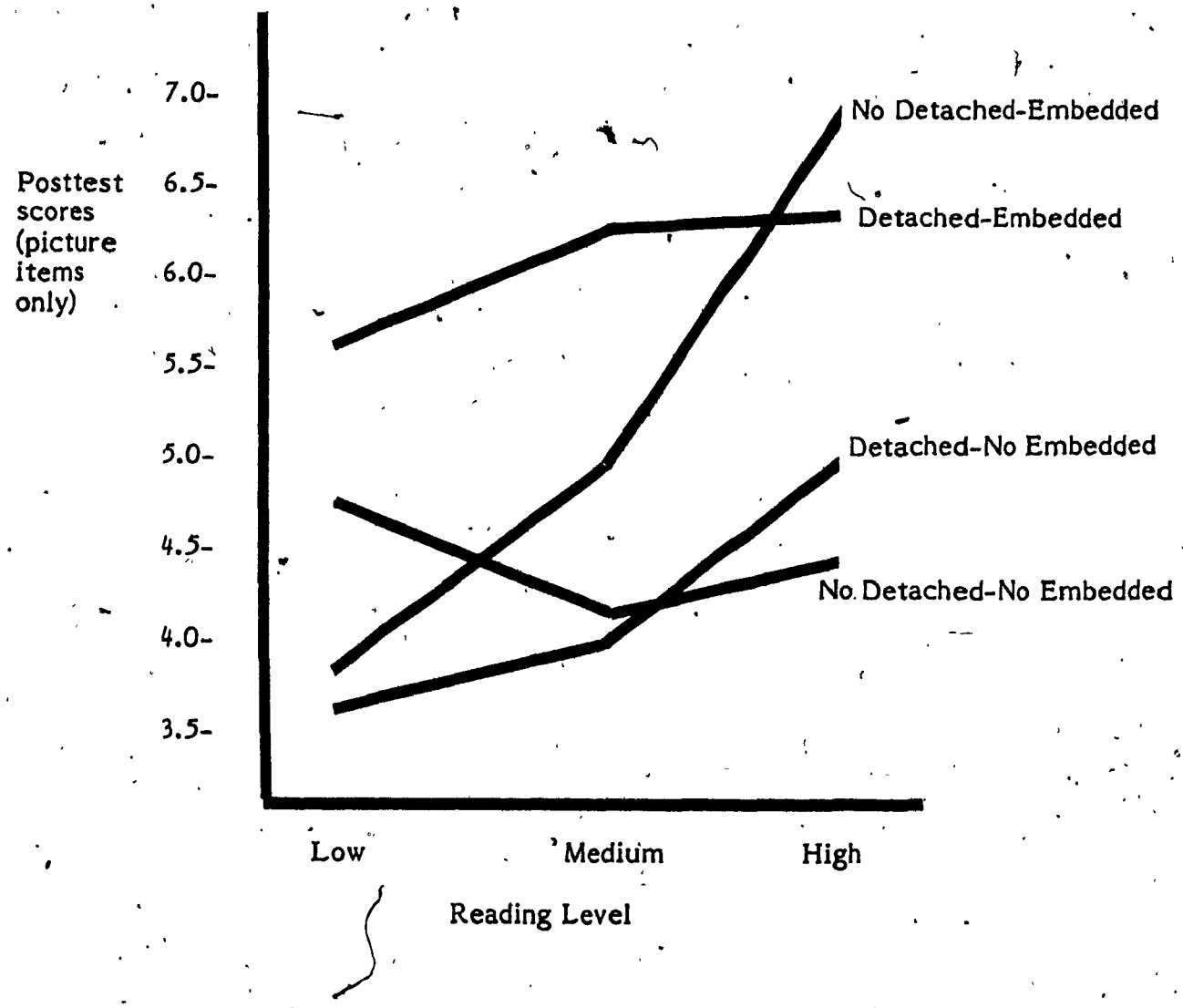


Figure 4: The effect of the Embedded Strategy on Posttest scores (picture items only) according to Reading Level.

involving more practical hands-on experience.

For the Posttest Items (Total), the Embedded Strategy was also shown to be significant. This indicates that students who received the implicit strategy, either alone or in combination with the explicit detached strategy, scored higher on the multiple choice test.

In order to determine whether the Embedded Strategy had a generalized effect across all test items or had a beneficial effect only on the picture-based items (for which it was purposely designed to enhance), the multiple choice test was divided into two sub-components: picture items only and text items only.

The results for the two sub-tests reveal that the Embedded Strategy was significant for the picture items only. It can be inferred then that the implicit "leading through the illustration" in conjunction with reading ability produced better retention of the information contained in the illustrations. Interestingly, the Embedded Strategy proved most effective for high ability readers -- a result not consistent with the ATI approach of Cronbach and Snow (1977). According to their approach, a compensatory device such as the embedded strategy should benefit low ability students without penalizing high ability learners. It may be that the literary nature of the adjunct strategy used in this study proved valuable only to those subjects who were better readers.

Based on the results of Experiment One, the experimental design and materials were modified for Experiment Two to examine the significant differences found. The nature of these modifications are detailed in the next chapter.

CHAPTER 4

EXPERIMENT TWO

Subjects

The subjects were 143 students at St. Clair College in Windsor, Ontario. They were in nine intact classes of between 8 and 50 students. They participated in the study as part of their regular English or Social Science course, a requisite for all students in the college.

Design

The study was a 2 x 3 factorial design with embedded strategy (inclusion and exclusion) and detached strategy (picture and no picture) as the two factors. In order to facilitate examination of the hypotheses, the revised design can be conceptualized as the dovetailing of two simpler component experiments: one that was an extension of the first study, and the second which attempted to control for the effect of pictures so as to elaborate on the effectiveness of the embedded strategy's significant results in Experiment One (see Figure 5).

Materials

The results of Experiment One indicated that the Detached Strategies included in the original conditions were not effective. For the second stage of the study, the detached strategies were revised according to the approach described by Rigney (1978). Whereas the detached strategy in the first experiment was merely a gross indication of the learning strategy to employ, the revised detached strategy sought to explicate, in a step-by-step fashion, the "how" of processing the specific illustration. This revised strategy took the form of a general study method for processing the information which could then be applied to other

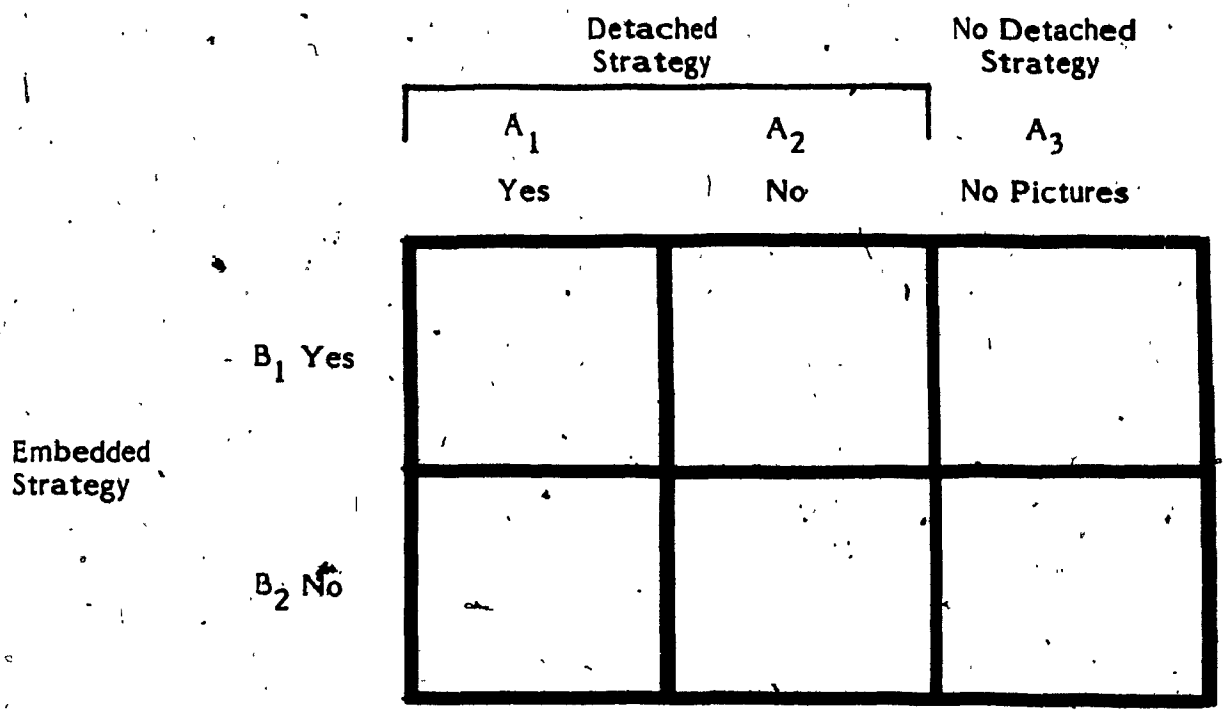


Figure 5: Dovetail design for Experiment Two including No Picture conditions

instructional contexts. In contrast, the embedded strategy which focused on the actual content of the illustrations remained unchanged. Indeed, this strategy had shown a significant effect on the comprehension measure and the decision to maintain its original form would serve to strengthen the control of extraneous factors. Instead, two control conditions, Picture-No Embedded strategy and No Picture-No Embedded strategy, were included to examine the effect of illustrations in text more thoroughly.

Instrumentation. The 25-item multiple-choice questionnaire was expanded to 30 items based on an item analysis performed on Experiment One data. Five items were added to increase the number of picture-based test items. The other items which attempted to present information in a more visual form were revised to add emphasis to the salient features (a weakness of Experiment One) which may have contributed to their inability to discriminate among conditions in the first experiment. Also, a cued free recall task was included to replace the free recall task which failed to provoke any meaningful subject response in Experiment One (see Appendix).

Procedure

The procedure remained unchanged from Experiment One.

Hypotheses

It was predicted that:

1. Subjects in the combinal condition (Detached and Embedded) would outperform all other groups on the picture-only test items.
2. There would be a significant main effect for the Embedded Strategy conditions (as was demonstrated in the Experiment One).

3. There would be a significant main effect for the Picture conditions as compared with the No Picture conditions. In other words, the pictures would be shown to contribute unique information no contained in the text.

Results of Experiment Two

The purpose of this study was to determine the relative effectiveness of detached and embedded learning strategies as enhancers of learning from illustrations.

Nelson-Denny Reading Test. Analysis of the Nelson-Denny Reading Test (NDRT) was conducted in two stages to determine relative effectiveness of reading ability as a predictor of individual performance on the criterion measures. In the first stage, the NDRT Total score was included in the analysis of the full model. It was found to be a significant factor (F (1,136) = 33.20, $p < .0001$). But previous research had suggested that the vocabulary and comprehension sections may be measuring different abilities and that the differences may have considerable implications for the present statistical analysis (Gellner, 1981; Picard, 1982). Therefore, a separate analysis was conducted on each of the two sections of the NDRT. The subsequent analysis revealed that there was a major discrepancy in the NDRT vocabulary test within the six conditions. The correlation matrix of the two criterion measures of the pictures items only (QRP - Cued Recall Test: Picture items only; QRV - Multiple Choice Test: Picture items only) are presented in Table 4.

The aberrant correlation of -.43 for the NDRT vocabulary component and the QRP was totally inconsistent with all other conditions. It was deemed necessary to exclude the vocabulary section of the NDRT from the rest of the analysis because the planned analysis involved correlation and the negative

Table 4

Correlation of Nelson Denny Scores (NDV and NDC) With Picture Items Only Scores (QRP and MCP)

		QRP	MCP
Detached - Embedded	NDV	.24	-.09
	NDC	.49	-.03
Detached - No Embedded	NDV	.46	.41
	NDC	.23	.05
No Detached - Embedded	NDV	.43	.24
	NDC	.67	.38
No Detached - No Embedded	NDV	.59	.43
	NDC	.58	.30
Embedded - No Pictures	NDV	.43	.37
	NDC	.37	.06
No Embedded - No Pictures	NDV	-.43*	.32
	NDC	.00	.31

correlation of NDV score would undermine further analysis. The mean scores of the NDRT vocabulary for all six conditions do not differ significantly, so no hypothesis can be put forth as to the atypical result due to group composition. The NDRT comprehension scores only were used as the covariate in the rest of the analyses.

Multivariate Analysis. A multivariate analysis was employed as an overall test of the experimental design. Unadjusted means and standard deviations of the six treatments for each of the criterion measures (QRP, QRV, MCP, MCV) are presented in Table 5. The MANCOVA analysis employed was the classical model where all factors except the one under analysis are held constant during the process. In this case, NDCOMP was held constant in the analysis (see Table 6).

As can be seen, there is a significant two-way interaction for the detached by embedded factors for the QRP (F (2,136) = 3.97, $p < .05$) and a marginally significant interaction for the MCP (F (2,136) = 2.01, $p < .13$) (see also Figure 6). The failure of the multiple choice to delineate effectively among the six conditions, when combined with the success of the QRP, suggests that it was the criterion measure which failed to measure a real difference rather than that no difference existed.

No significant differences were found among the six conditions for any of the text items only criterion measures.

Analysis of Pictures Items Total Scores

In order to compensate for the weakness in reliability of the multiple choice test, it was decided to combine the two sub-tests scores of the cued recall (picture items only) and multiple choice (picture items only) into a single score known as PTOTAL (picture items only). This procedure is justified because both

Table 5

Unadjusted Means and Standard Deviations for All Criterion Measures

			Detached	No Detached	No Detached No Pictures
QRP	Embedded B_1	x =	5.92	6.38	4.84
		sd =	3.94	4.34	3.30
		n =	25	24	25
	No Embedded B_2		6.43	4.13	1.63
			4.91	3.19	1.47
			21	24	24
QRV	Embedded B_1		3.52	3.96	3.64
			1.83	2.51	2.55
	No Embedded B_2		3.29	3.71	3.54
			1.59	2.12	2.38
MCP	Embedded B_1		7.00	7.58	6.68
			2.20	2.99	1.82
	No Embedded B_2		6.43	5.71	4.25
			2.58	2.20	1.94
MCV	Embedded B_1		3.88	4.33	4.04
			1.76	2.12	1.84
	No Embedded B_2		4.29	5.29	4.13
			1.87	1.88	1.94

Table 6

Results of MANCOVA Analysis Showing Significant Interaction (DET x EMB) Effect for QRP and MCP

	SS	DF	MS	F	Sig of F
QRP	86.36	2	43.18	3.97	.021
MCP	20.98	2	10.49	2.01	.138

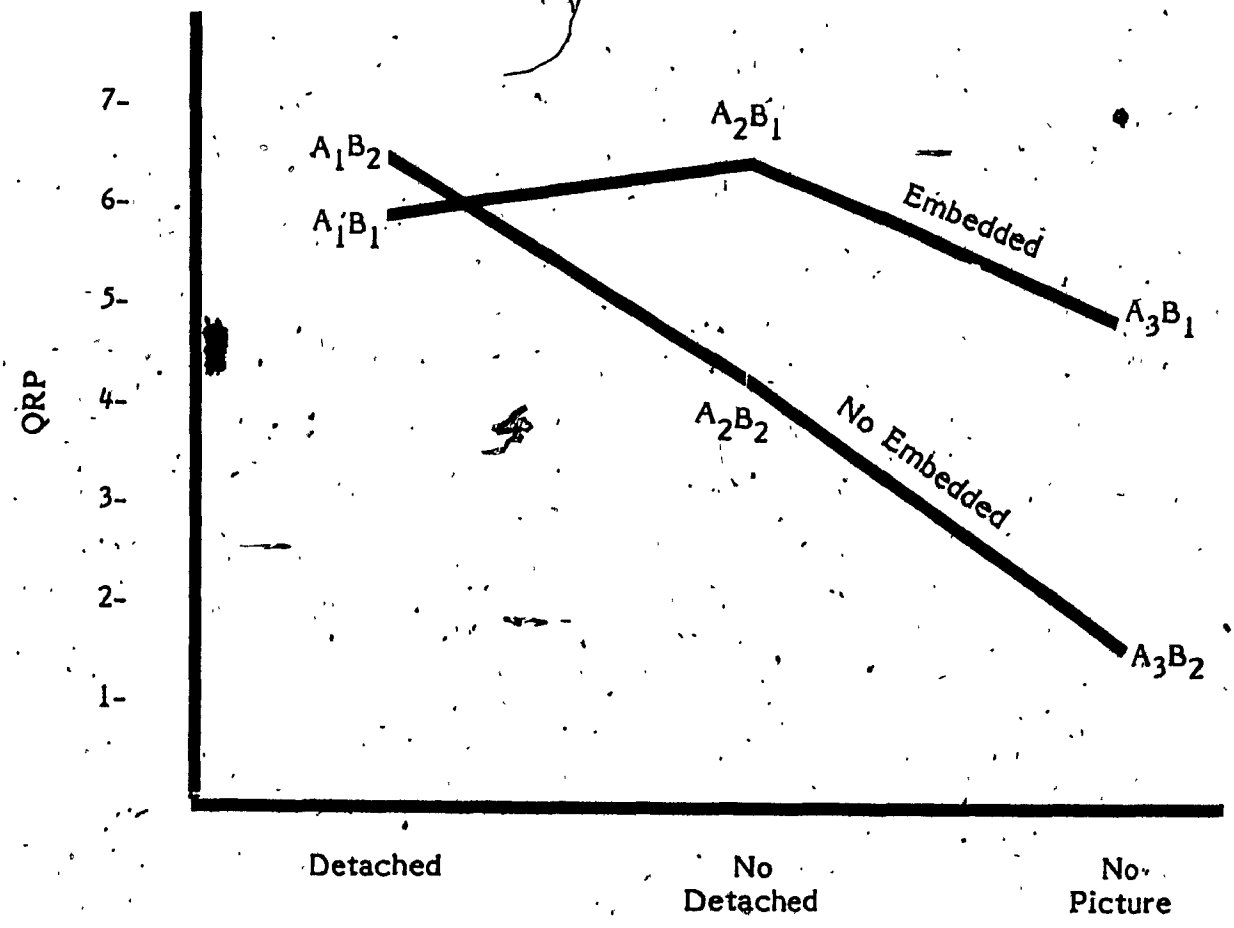


Figure 6: Graph of significant interaction of Embedded and Detached strategies for the criterion measure QRP.

criterion measures appear to tap the same cognitive ability (Rigney, 1978). The means and standard deviation for all six conditions appear in Table 7.

An analysis of covariance was performed on the transformed scores. The results are detailed in Table 8. The interaction of the two learning strategies -- detached and embedded -- for the combined picture score was significant ($F(2,134) = 5.02$, $p < .01$).

This significant interaction did not permit an analysis of the main effects for each strategy separately. Post hoc comparisons were used to find out exactly where the significant differences exist among the conditions.

In order to reduce the influence of chance due to having more than one comparison, the conservative Scheffe procedure was employed. The results of Scheffe's test are summarized in Table 9.

A graphic representation of the comparisons examined are indicated in Figure 7. Due to the fact that the number of subjects in each condition were not equal, a harmonic mean was used for calculation purposes.

Three comparisons proved significant: A_2B_1 and A_2B_2; A_2B_1 and A_3B_2; and A_2B_2 and A_3B_2.

Summary of Results

The reading ability of learners as measured by the Nelson-Denny Reading Test was found to be a significant factor in the present research design. As the vocabulary sub-component of the test was shown to be inconsistent across the six treatment groups, the comprehension section was deemed the appropriate covariate to be included in the further analyses.

A significant effect for the two strategies was identified for the cued recall (picture items only) while the multiple choice questionnaire was found to be marginally significant. Therefore, it was decided that the two picture-based

Table 7

Combined Means and Standard Deviations for Picture Items Only (PTOTAL)

		Detached Strategy		No Detached Strategy
		A_1	A_2	A_3
		Yes	No	No Pictures
Embedded Strategy	B_1 Yes	x = 12.92 sd = 4.68 n = 25	13.96 6.03 24	11.52 4.23 25
	B_2 No	12.86 6.00 21	9.83 4.62 24	5.88 2.33 24

Table 8

Analysis of Covariance Using Transformed Scores (PTOTAL)

	SS	DF	MS	F	Sig of F
NDCOMP by DET by EMB	11.08	2	5.54	.29	.74912
DET by EMB	191.99	2	95.99	5.02	.00793 *
DET	548.11	2	274.06	14.32	.00001
EMB	496.36	1	496.36	25.94	.00001
NDCOMP	359.22	1	359.22	13.78	.00003
Within + residual	2564.49	134	19.14		

* $p < .01$

Table 9

Results of Scheffe test

	A_1B_1	A_1B_2	A_2B_1	A_2B_2	A_3B_1	A_3B_2
A_1B_1						
A_1B_2				(6.12) 1.31		
A_2B_1				(3.91) * 11.15	(6.12) * 8.51	
A_2B_2						(6.12) * 10.26
A_3B_1						(3.91) * 24.55
A_3B_2						

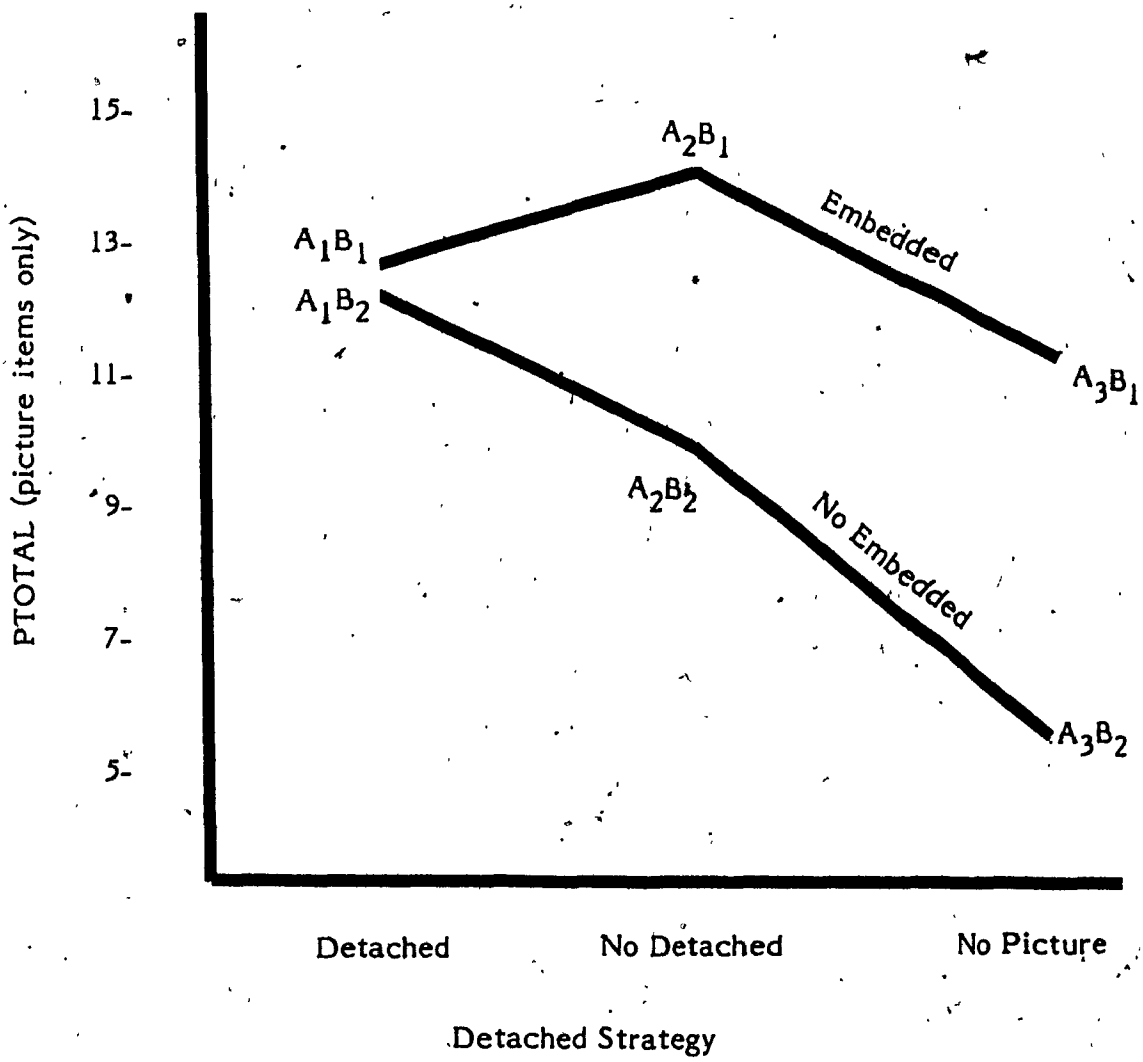


Figure 7: Graphic summary of results of Experiment Two using Scheffe procedure.

criterion measure would be combined into one measure labelled PTOTAL. A significant interaction between embedded and detached learning strategies was found for the Total Picture score. Post hoc comparisons revealed significant difference among conditions.

CHAPTER 5

DISCUSSION

Verbal Items Only

As the analysis revealed, there were no significant effects for either independent variables, whether used in isolation or in combination for the verbal test items.

The results indicate that there is no transfer of the effects of strategies which support pictures to the textual material surrounding them. This is perhaps due to the fact that the strategies were specifically directed to the deciphering of the visual information and therefore, added little to influence retention of the passage. This may be evidence for the functional role of illustrations put forth by Duchastel (1978). The pictures were not designed as visualized support for the text, but as representations of unique and discrete concepts. Therefore, there was no generalized effect for the strategies employed.

Picture Items Only

The results of the data analysis revealed that there was a significant interaction of the two independent variables, detached and embedded learning strategy. This interaction acts to limit the specificity of the conclusions drawn from the data. Also, the presence of each strategy benefitted some students.

Due to the significance of the interaction of the two independent variables, it is not valid to examine the individual main effects for each type of strategy. But visual inspection of the pattern of group scores on picture test items suggests a strong overall effect for the embedded cognitive strategy whether in combination with the detached learning strategy or by itself. Constrained by the fact of a significant interaction the analysis continued with a post hoc of the

various conditions.

Post hoc analysis of the differences among the groups allowed more specific conclusions. A comparison of groups who had both detached and embedded strategies with those who received only the detached strategy reveals that there was no difference between the two groups. In fact, the overall mean pict scores were almost identical. If this information is combined with a second comparison between the detached and embedded condition with the embedded strategy only condition, it is clear that all three groups performed similarly. These results differ from Experiment One where only the Embedded strategy was shown to be effective. Therefore, the conclusion is that designers of instructional materials containing illustrations should include one or the other or both strategies to improve the effectiveness of the materials. It appears that it is important to include some cueing mechanism to provoke the learner to derive the salient information contained in the illustrations. Whether this provocation is explicit as in the detached learning strategy or implicit as demonstrated by the embedded learning strategy is not an issue. It is clear, though, that illustrations do need to be presented in a specific manner, not simply included without any contextual support.

Two of the post hoc comparisons which shed some light on the effectiveness of the embedded learning strategy are that between the No Detached-Embedded condition and the No Detached-No Embedded condition and that between the No Picture-Embedded group and the No Picture-No Embedded group. The first comparison yields a significant result in that those subjects who receive the Embedded Strategy Only did significantly better than those who did not receive either of the learning strategies. Therefore, material which contained pictures without any contextual support did not provoke the desired outcomes. The embedded learning strategy which led the learner step-by-step through the

information contained in the illustrations was effective even without the more explicit detached strategy.

More interesting was the comparison between the two groups which received no illustrations. In the first of the two groups, the subjects received material in which only the embedded learning strategy was included. The second condition contained neither the pictures or the embedded. The significant difference between these groups reveals a compensatory power for the strategy. Even though subjects did not receive the illustrations, they were able to score significantly better on the picture-based test items when exposed to the embedded strategy. It appears that a detailed verbal description of the concepts typically represented in an illustration was sufficient to produce this effect.

The final post hoc comparison was directed to the question of what effect did the inclusion of pictures have on the learning outcomes. To answer this question, the comparison of the No Detached-No Embedded condition and the No Picture-No Embedded condition was carried out. The significance of this result reveals that the picture group did gain unique information that was not only attributable to the inclusion of the embedded strategy as revealed by the prior comparisons. The group which had no strategies but only the illustrations still scored better than the group which received neither. Therefore, we can conclude that the pictures contained unique information for the learner.

Although the present study failed to identify one foolproof strategy for incorporating illustrations in learning materials, it does suggest that instructional designers should include some mechanism to provoke the learner to use the illustrations for their intended purposes. The results acknowledge the unique role illustrations perform as conveyors of information, but cautions educators to use them for specific purposes and in a manner which will ensure their effectiveness as a means of instruction, not merely as window dressing.

REFERENCES

Anderson, John R. (1978) Arguments concerning representations for mental imagery. Psychological Review, 85, 249-275.

Anderson, J.R. and Bower, G.H. (1973) Human Associative Memory. Washington, D.C.: Hemisphere Press.

Brody, P.J. (1981) Research on pictures in instructional texts: The need for a broadened perspective. Educational Communication and Technology Journal, 29, 93-100.

Bovy, R.C. (1982) Successful instructional methods: A cognitive information processing approach. Educational Communication and Technology Journal, 29, 203-217.

Cronbach, L.J. and Snow, R.E. (1977) Aptitude and Instructional Methods: A Handbook for Research on Interactions. New York: Irvington.

Dansereau, D.F. et al. (1979) Development and evaluation of a learning strategy program. Journal of Educational Psychology, 71, 64-73.

Dean, R.S. and Kulhavy, R.W. (1981) Influence of spatial organization in prose-learning. Journal of Educational Psychology, 73, 57-64.

Duchastel, P.C. (1980) Research on illustrations in text: Issues and perspectives. Educational Communication and Technology Journal, 28, 283-287.

Duchastel, P.C. (1981) Illustrations in text: A retentional role. Programmed Learning in Educational Technology, 18, 11-15.

Duchastel, P.C. and Waller, R. (1979) Pictorial illustration in instructional texts. Educational Technology, November, 20-25.

Dwyer, F.M. (1978) Strategies for Improving Visual Learning: A Handbook for the Effective Selection, Design and Use of Visualized Materials. Pennsylvania: Learning Services.

Fleming, M. (1967) Classification and analysis of instructional illustrations. AV Communication Review, 15, 246-256.

Gellner, R. (1981) An investigation of the effects of a pictorial overview on adult learning of prose text. Unpublished master's thesis, Concordia University, Montreal, Quebec.

Gombrich, E.H. (1960) Art and Illusion. Princeton, N.J.: Princeton University Press.

Levie, W.H. and Lentz, R. (1982) The effects of text illustrations: A review of research. Unpublished manuscript, Audio-Visual Center, Indiana University, Indiana.

Melzack, R. (1966) The perception of pain. In S. Coopersmith (Ed.), Frontiers in Psychological Research: Readings from Scientific American (pp. 195-201). San Francisco: W.H. Freeman & Company.

Paivio, A. (1971) Imagery and Verbal Processes. New York: Holt, Rinehart and Winston.

Picard, J. (1982) An investigation of the effects of conceptually integrated images on prose comprehension in high and low prior knowledge adults. Unpublished master's thesis, Concordia University, Montreal, Quebec.

Pylyshyn, Z.W. (1973) What the mind's eye tells the mind's brain: A critique of mental imagery. Psychological Bulletin, 80, 1-24.

Rigney, J.W. (1978) Learning strategies: A theoretical perspective. In H.F. O'Neil (Ed.) Learning Strategies. New York: Academic Press.

Winer, L.R. and Schmid, R.F. (1986) Using Brunerian learning theory with educational simulations to teach concepts. Canadian Journal of Educational Communication, 15(3), 153-165.

Winn, William (1982, May) Status and trends in visual information processing. Paper presented at the annual meeting of the American Educational Research Association, Dallas, Texas.

APPENDIX

DIRECTIONS

You will have thirty minutes (30) in which to study the following unit entitled 'The Nature of Pain'.

Please study the unit very carefully because you will be asked to answer some short answer questions and a thirty (30) item multiple choice test once you have finished. Feel free to 'study' the material in the same way you do any of your regular subjects - i.e., underline, re-read, asterisk.

If you have any questions, please raise your hand now and you will be assisted.

PLEASE DO NOT TURN THE PAGE
UNTIL INSTRUCTED TO DO SO.

Legend:
Detached strategy marked |
Embedded strategy marked ||

Our society could be described as one 'obsessed' with pain. One measure of this obsession is the amount of money spent on pain-relievers each year - an estimated 10 to 25 billion dollars a year (Melzack, 1973). Aspirin, Anacin, Bufferin, Valium, tranquilizers, alcohol, antacids, morphine, Alka-Seltzer... are all remedies for a public who suffers from the 'pain' of upset stomachs, hemorroids, itchy rashers, powerful headaches, backache, irregularity... The list goes on and on.

In view of all the time and money spent on pain, it is remarkable that few professionals agree on a definition of 'pain'. One thing is certain: pain is not an object. It is not a tangible substance easily described, measured or treated. It is, at the very least, a

> "...subjective experience determined by a complex interplay of biological, psychological and social factors." (Bond, 1979)

Pain becomes an entity unto itself, which may be measured and treated, only when the individual sufferer reports it to another person. In this way, it takes on an identity of its own.

Although it would be difficult to give an intelligent answer to the question 'What do we feel pain with?', it would be even harder to understand someone who claimed to have a pain but was unable to say where it was. Sensations are sometimes far away from the place where the cause is, but they are always located somewhere: they have a distinct and characteristic site, even if it is misleading. Naturally, some pains - those we call 'stabs' and 'shoots', for instance - are more sharply located than other. Those we call 'aches' tend to have a fuzzy, thick feeling without any sharp outline. But even the vaguest pain can be pointed to, although you may use your whole hand rather than the tip of your finger. In fact, a lot can be learnt about a pain from the way in which the patient points to it. Apart from saying something about where it is, the movement of the hand is often a tell-tale sign of its quality: if someone has angina (heart-related pain), he often presses the front of his chest with a clenched fist; the whole fist shows that the pain is widespread; the fact that the hand is clenched tells us the pain has a gripping quality. The pain from peptic ulcer is often closely localised, and the patient usually tells you so by delicately pointing to it with the tip of his index finger. If a pain is more or less superficial - what would normally be called soreness - the patient may lightly brush the surface of the skin with the outstretched tips of all five fingers. The skilled physician can learn a lot from the pantomime of complaint.

Although it is hard to imagine an unlocated pain, there are strong sensations or feelings which are not recognisably associated with a part of the body. It is very hard to say where you feel nausea, for example. If you ask people, they often simply say that it is what they feel when they know they are going to be sick.

If we want to locate the "experience" of pain in the person, it is best to think of it as happening in the 'felt-self' (Miller, 1978). The 'felt-self' corresponds only loosely to the biological self: it is the projection of the body and its parts onto the brain. (see Figure 1)

Examine the diagram below. Beginning at the top righthand corner, read the labels corresponding to each body part. Next, note the relationships among the different parts carefully. Try to visualize the location of these parts in terms of your own brain. Repeat the list of body parts and their location while you do this.

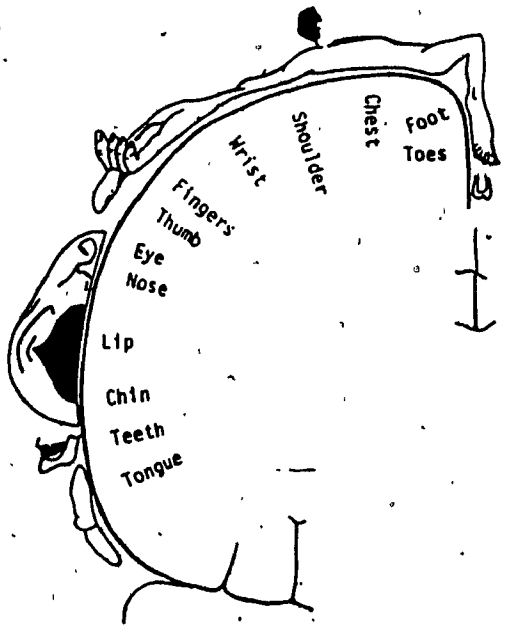


Figure 1: The 'felt-self'

Notice that the location of the nerves in the brain are in the reverse order from their actual bodily position. Also, the proportions (size) of the body parts in the 'felt-self' are not the same as those in the physical self (i.e., the mouth is much larger than the calf) - this may explain why the pain associated with a toothache seems greater than that of a leg cramp.

Pain, therefore, is both a physiological (i.e., body) and a psychological (i.e., mind) experience. It is not possible to separate these two components of pain. All types of pain can be described using these two concepts.

The main physiological components involved in the perception of pain include the body tissue, the biochemical mechanisms and the brain function. Pain will be experienced as the result of damage to, or change in, one of these three areas. These three physical mechanisms can produce, together or individually, the sensations we describe as pain. (These features will be explored in more detail when we discuss types of pain.)

The psychological aspects of pain include all the personality traits, individual characteristics, and past experiences which influence the amount (how much?) and the intensity (how strong?) of pain felt. It has been shown, for instance, that the perception of pain is heavily influenced by the attention focused on it. It is well known that prize fighters, football players and other athletes can sustain severe injuries without being aware that they have been hurt. In fact, almost any situation that attracts intense, prolonged attention may diminish or abolish pain perception. Formal recognition of this fact has led to increasing medical interest in hypnosis. Evidently a small percentage of people can be hypnotized deeply enough to undergo surgery entirely without anathesia. For a larger number of people hypnosis reduces the amount of pain-killing drug required to produce successful analgesia.

If, however, the subject's attention is focused on a potentially painful experience, he will tend to perceive pain more intensely than he would normally. Researchers found that the use of the word 'pain' in a set of instructions made anxious subjects report as 'painful' a level of electric shock they did not describe as painful when the word was not in the instructions. (Melzack, 1961)

The meaning associated with a painful situation can also change the amount of pain we perceive:

> "During World War II, a researcher observed the behavior of soldiers severely wounded in battle. He was astonished to find that when the wounded were carried into combat hospitials, only one out of three complained of enough pain to require morphine. Most of the soldiers either denied having pain from their extensive

> wounds or had so little that they did not want any medication to relieve it. These men were not in a state of shock, nor were they totally unable to feel pain, for they complained as much as anyone else about a badly administered needle. When the researcher returned to everyday practice he asked a group of civilians who had just undergone major surgery and who had incisions similar to the wounds received by the soldiers whether they wanted morphine to lessen their pain. In contrast with the wounded soldiers, four out of five claimed they were in severe pain and pleaded for a morphine injection." (Melzack, 1961)

Other factors which effect the individual's subjective experience of pain include: experiences from childhood (these are often different according to sex), ethno-cultural attitudes (Latin races often complain much more freely and seek treatment sooner than northern European races) and family attitudes (in some families, people are rewarded with too much attention for being sick). As you can see, there are many influences that help to shape an individual's attitudes toward pain and, therefore, their experience of pain.

There are three types of pain: ORGANIC, PSYCHOSOMATIC and PSYCHOGENIC. Any pain can be classified as one or a combination of these types.

Organic pain is pain produced by physical disease or injury. Surgery, cancer or a broken leg all result in organic pain. This type of pain can be directly linked with a physiological source. This is not to say that there are no psychological (mind) features in organic pain. Remember, all pain has both components to different degrees. But organic pain has a physical source.

Organic pain can also be qualitatively divided into 'acute' and 'chronic' pain. 'Acute' pain is pain which is short-term and needs immediate treatment. 'Chronic' pain, on the other hand, is pain which accompanies longterm illness and is thought of as having no end or little possibility of control.

(It is impossible to give a complete explanation of how the pain mechanism works in the body. This would require a complete course in itself. The following section is simply intended to identify the main elements of what may be described as a 'pathway' for pain.)

Pain, as far as we know, is transmitted electro-chemically from the neuron, or nerve cell, located at the site of the trauma to the sensory cortex in the brain. (see Figure 2)

Study the diagram carefully. Locate and name the main parts of the nervous system included in the illustration. Next, trace the pain process represented step-by-step in the direction of the arrows. While you trace the route, describe it in your own words to help you remember it.

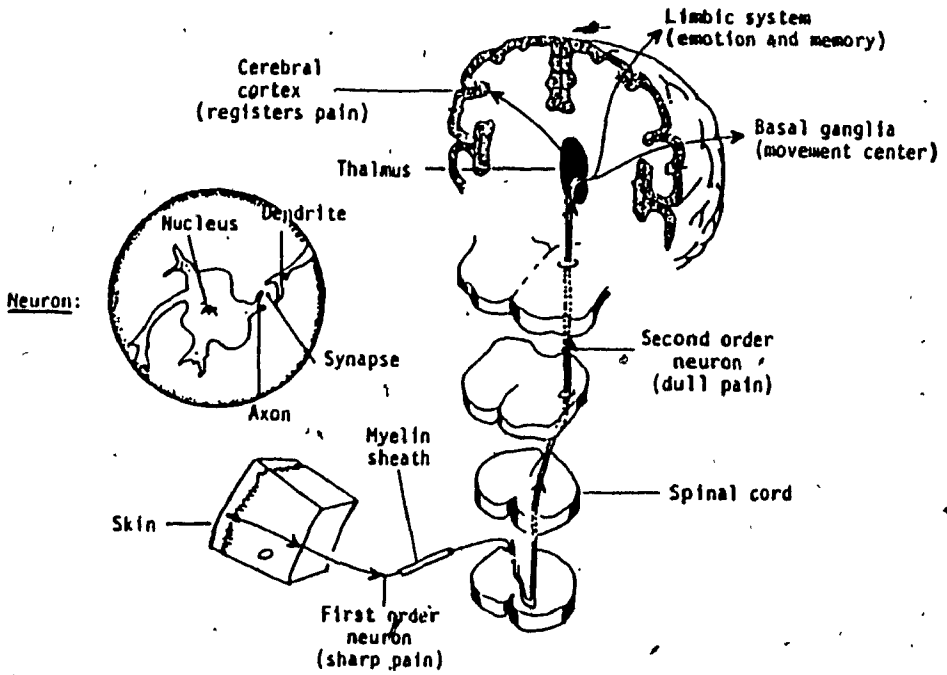


Figure 2: The 'pathway' of pain

The neuron consists of cell body, a nucleus, axons and dendrites. Dendrites register the impulses - they are the 'receivers', if you like. The axons conduct the impulses across the synapse (the gap between the neurons) to other parts of the nervous system - the 'senders'. The sheath which surronds the axon contains a substance, myelin, which effects the speed at which the electrical impulses can be conducted. First-order neurons with a thick myelin sheath carry information about sharp

pain, while second-order neurons with a thin myelin sheath act as a slow pathway for dull pain. Both pathways travel up the spinal cord and terminate in the thalmus where the signals are distributed to the cerebral cortex (where pain is registered), to the limbic system (where emotions and memory is aroused) and to the basal ganglia (where movement originates).

To complete your understanding of the process, we should add that there are two basic theories for how pain is actually transmitted:

1. A sensory theory which proposes that pain is a sensory occurrence with specific receptors, pathways through the nervous system, and centers in the brain.

2. An intensity theory which takes the view that specific receptors for pain do not exist and that pain results from stimulation of any means so long as the stimulation is strong enough.

Nowadays it is accepted that both theories are needed for a general theory of pain. As it turns out, there are nerve fibres which are specific for pain, and stimulation of both pain-specific and non-pain-specific fibres may give rise to pain.

Pain which results from physical disease which is started and maintained chiefly by psychological factors is called psychosomatic pain. Psychosomatic disorders tend to be intermittent, appearing at times of stress (which is defined as the condition which results when circumstances threaten the emotional well-being of the individual.

The general sequence of events which produces psychosomatic pain is: the body, responding to disturbances of emotion, produces effects through the autonomic system (nerves and glands) which produce physiological symptoms. (see Figure 3)

Examine the process represented in the diagram below. Notice the sequence in which the events take place and the overall pattern these events form.

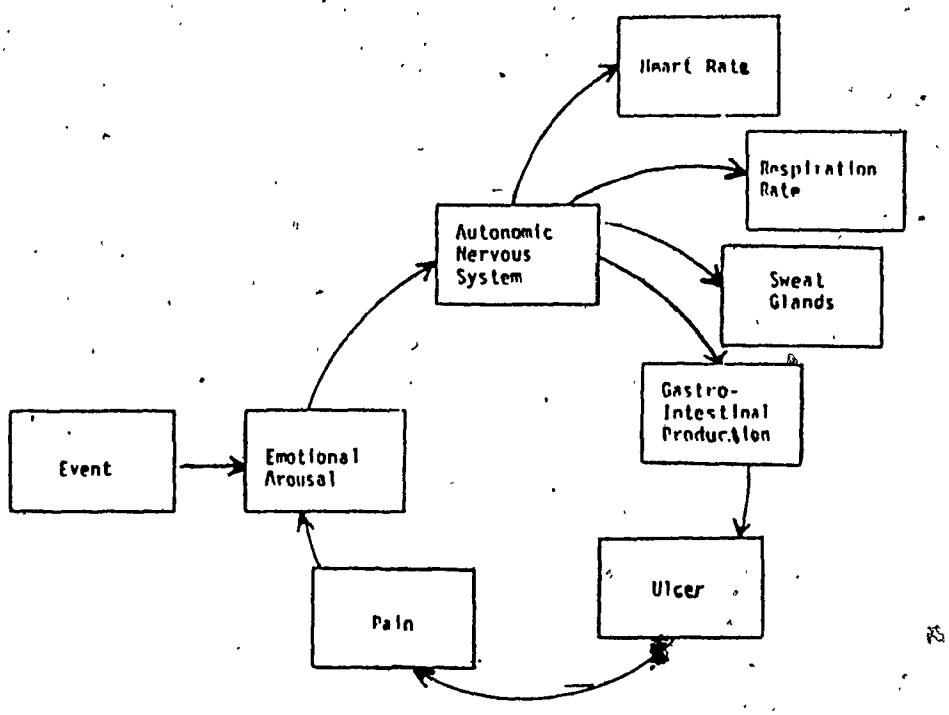


Figure 3: The Ulcer Cycle

For example, for an ulcer, if emotion is suddenly aroused by fright (an event), there are increases in heart rate, respiration rate, sweating and gastro-intestinal function. If these alterations are repeated for a long period of time, the amount of acid produced in the stomach will reach a dangerous level - the result is physical damage known as an ulcer.

More subtle and more extended physiological responses manifest as disorders of skin, musculo-skeletal, respiratory and gastro-intestinal and cardiovascular systems. Peculiarly, the same manifestation of stress such as asthma, ulcers, migraine headaches and colitis, will often occur within a single family - evidence for the 'learned' nature of pain.

Psychogenic pain occurs without the presence of an obvious physical cause, although it is often located at the site of a previous trauma or injury. It is difficult to explain why an individual believes that they have a physical problem rather than a psychological one. Perhaps it is more acceptable to

themselves and society to have a 'real' (i.e., physical) pain rather than face their feelings about some upsetting issue. The ability of the human being to transpose pain of one sort to another is astounding and not to be underestimated.

For example, a person may be undergoing a lot of stress and complains of a pain in the side of his face (i.e., known as trigeminal neuralgia). After x-rays and an examination, the doctor finds there's no evidence of anything wrong physically - no cavities or sores or infection. But still the patient reports having pain. The doctor may suspect that this pain (though real to the patient) is really related to the psychological reaction of the person to other underlying problems. Instead of feeling 'stress' or 'anger', they 'feel' a physical pain.

Psychogenic pain, then, is the physical expression of a psychological problem. The pain is often a symptom of neurosis, usually associated with anxiety, depression, hypochondriasis (i.e., a hypochondriac) and hysteria. Often it develops in response to an emotionally stressful situation. If the person has inadequate strategies for coping with emotional difficulties, they may complain of physiological 'aches and pains'. Remember, though, the pain they feel is real. Treatment such as psycho-therapy is usually recommended for psychogenic pain.

A summary of the three types of pain - ORGANIC, PSYCHOSOMATIC and PSYCHOGENIC - is presented in the table below. (see Figure 4)

Examine the following summary chart carefully. A summary chart contains a lot of information and takes time to decipher all of it. Study the key in the upper lefthand corner. Notice that each square has a different meaning. Next, read the detailed description of each characteristic and notice in which types of pain it occurs. Compare and contrast the different types of pain in terms of the characteristics listed.

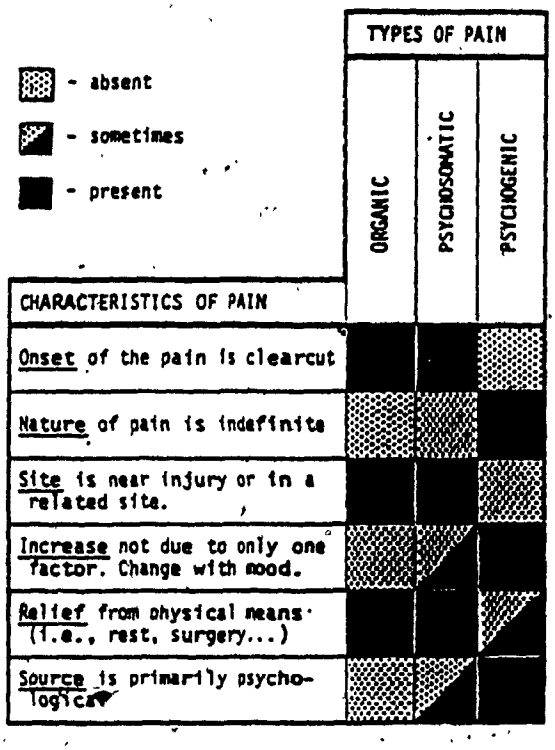


Figure 4: Chart of the characteristics of ORGANIC, PSYCHOSOMATIC and PSYCHOGENIC pain

There are six major characteristics which we can use to distinguish the three types of pain. They are: Onset, Nature, Site, Increase, Relief and Source. As you can see, Organic and Psychosomatic pain share many common features. This is because of the actual physiological components of both kinds of pain (Source). They tend to have appeared at an identifiable time (Onset), have a specific location that does not change (Site), and the treatment is mainly through physical means such as surgery or rest (Relief). In contrast, Psychogenic pain appears gradually (Onset), the pain is difficult to describe (Nature), the location and intensity changes under different circumstances or moods (Site and Increase), treatment is usually through stress reduction and relaxation (Relief) and psychological factors are the primary Source.

TEST DIRECTIONS

This test consists of thirty (30) multiple choice questions which are based on the unit.

You should find an answer sheet included in the envelope. Please use this sheet to record your answers.

Please answer all questions. If you don't know or are not sure which is the correct response, select the one which you think is most likely to be correct.

EXAMPLE:

Q. 1 The Prime Minister of Canada is:

a. Gary Trudeau

b. Margaret Thatcher

c. Margaret Trudeau

d. Pierre Trudeau

e. Pierre Lalonde

Obviously, the correct answer is (d) and you would indicate this by circling (d) beside the appropriate question on the answer sheet.

1. a b c (d) e

Should you make a mistake and want to change your answer, just cross out your original choice with an "x" and then circle your new choice:

1. (x) b c (d) e

Before you begin..... DO YOU HAVE ANY QUESTIONS?

Name: _____

PART I

Answer the following questions in the space provided:

1. The unit entitled "The Nature of Pain" described three types of pain. List them.

2. The term 'pantomime of complaint' was refered to in the text. Give two examples.

   a.

   b.

3. Where is pain located according to Miller?

4. What is the relationship of the physical self to the 'felt-self'?

5. List the main physiological components of the 'pathway of pain'. Describe the role of each component in the experience of pain.

6. Two different theories are necessary to fully understand how pain functions in the body. Name them,

   a.

   b.

7. The cycle for producing an ulcer was presented in the text. List the main events <u>in the sequence</u> in which they occur.

a.

b.

c.

d.

e.

f.

g.

h.

i.

8. List <u>three</u> examples of Psychogenic pain.

a.

b.

c.

9. Pain can be classified using six characteristics according to the text. List as many as you can remember and provide a brief description of each.

10. The unit referred to <u>two</u> main features that are used to describe any pain. List them.

a.

b.

Items marked with (*) added in revised test for Experiment Two.

MULTIPLE-CHOICE TEST

1. Physiological mechanisms which are involved in the process of pain include:

    1. body tissue
    2. internal organs
    3. biochemical
    4. brain tissue

    a. 1,2 and 3
    b. 1,2 and 4
    c. 1,3 and 4
    d. 2,3 and 4
    e. all of the above

2. The order and position of body parts in the 'felt-self' are:

    a. in no particular arrangement.
    b. the same as in the actual physical self.
    c. different in each individual.
    d. in reverse order of the physical self.
    e. not enough information to answer the question.

3. The myelin sheath is:

    a. a special type of neuron.
    b. a part of the spinal cord.
    c. a coating on the neuron.
    d. a layer of the cerebral cortex.
    e. not enough information to answer the question.

4. Based on the concept of the 'felt-self', which of the following statements is false?

    a. A pain in the thumb will feel greater than one in the mouth.
    b. A pain in the chest will feel greater than any other pain.
    c. A toothache will feel greater than a sprained toe.
    d. A broken arm will feel about as painful as a broken leg.
    e. not enough information to answer the question.

* 5. Psychosomatic and psychogenic pain are similar because:

    a. both have primarily physiological sources.
    b. both have primarily psychological sources.
    c. both respond to primarily physical treatments.
    d. both increase with changes in mood.
    e. both have primarily indefinite natures.

*6. Select the list which contains the correct physiological elements of the 'pathway' of pain:

a. spinal cord, neurons, hypothalmus, cerebral cortex, myelin sheath
b. spinal cord, cerebral cortex, thalmus, neurons, myelin sheath
c. spinal cord, neurons, veins, thalmus, cerebral cortex, arteries
d. spinal cord, neurons, thalmus, thyroid, cerebral cortex, myelin sheath
e. spinal cord, myelin sheath, sensory cortex, neurons, hypothalmus

7. Which of the following statements is false?

a. Pain has a highly specialized medical vocabulary we use to describe its location and intensity.
b. Pain only becomes an object (i.e., thing) when it is described to someone else.
c. Pain is a subjective experience, not easily described, measured or treated.
d. Pain has both physiological, psychological and social components.
e. None of the statements is false.

8. The major characteristics by which we classify pain include:

a. Increase, Onset, Intensity, Relief, Site, Source
b. Relief, Increase, Decrease, Source, Site, Onset
c. Mood, Nature, Type, Onset, Relief, Increase
d. Decrease, Mood, Source, Site, Increase, Nature
e. Onset, Site, Source, Nature, Relief, Increase

9. Characteristics of 'psychosomatic' pain include:

a. a physiological cause, but a psychological symptom
b. a psychological cause, but a physiological symptom
c. both psychological and physiological symptoms.
d. all of the above combinations are possible for psychosomatic pain
e. none of the above are correct

10. Research on the role of attention in the perception of pain has led to interest in:

a. acupuncture
b. hypnosis
c. memory
d. individual differences
e. drugs

11. Which of the following statements is false?

    a. All three types of pain have some features in common.
    b. Organic pain and psychogenic pain have a lot in common.
    c. Each type of pain has a distinct set of characteristics.
    d. A characteristic is either present or absent in each type.
    e. Not enough information in the unit to answer the question.

12. The psychiatric expression, "He's a real pain in the face", refers to:

    a. organic pain
    b. psychosomatic pain
    c. psychogenic pain
    d. both organic and psychosomatic pain
    e. both psychosomatic and psychogenic pain

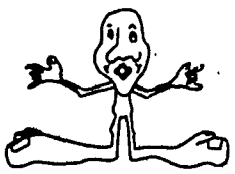
13. A patient describes his pain using a clenched fist. This is an example of:

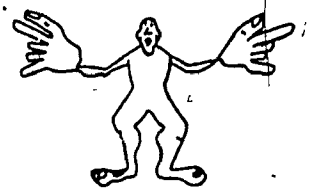
    a. the pathway of pain
    b. the felt-self
    c. the pantomime of complaint
    d. the learned nature of pain
    e. the cycle of pain

14. Another name for the cerebral cortex is the :

    a. limbic system
    b. motor cortex
    c. basal ganglia
    d. sensory cortex
    e. brain tissue

* 15. If a model of a person was built according to the proportions of the 'felt-self', it would look like:

a. 

b. 

c. 

d. 

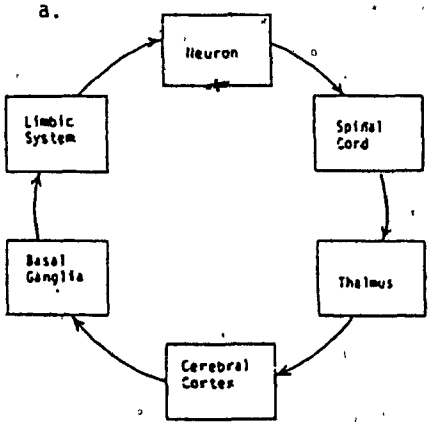
e. Not enough information in the unit to answer the question.

16. The 'pantomime of complaint':

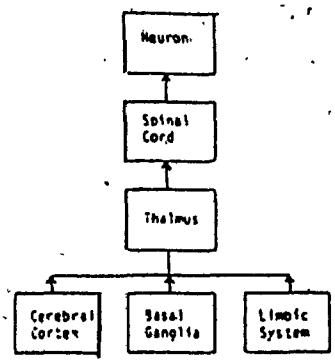
a. shows exactly where the physical damage causing the pain is located.
b. tells the doctor about the quality of patient's pain.
c. is usually inaccurate and therefore unimportant for the diagnosis.
d. is confusing to the doctor and should be ignored.
e. is none of the above.

17. Choose the flow diagram that best represnts the same 'pathway' of pain as described in the unit.

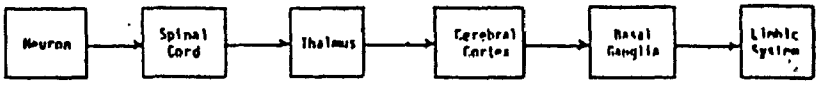
a.



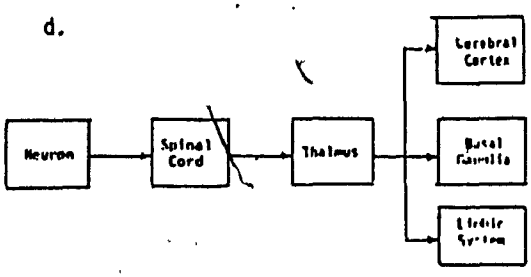
b.



c.



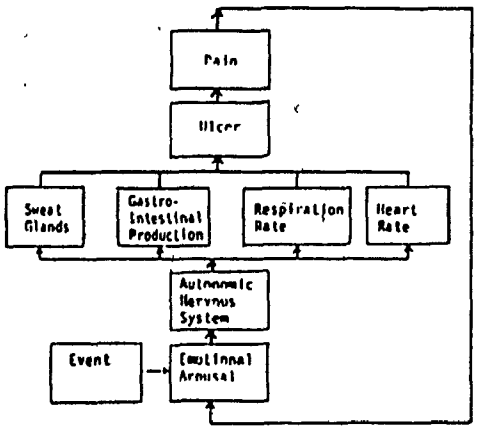
d.



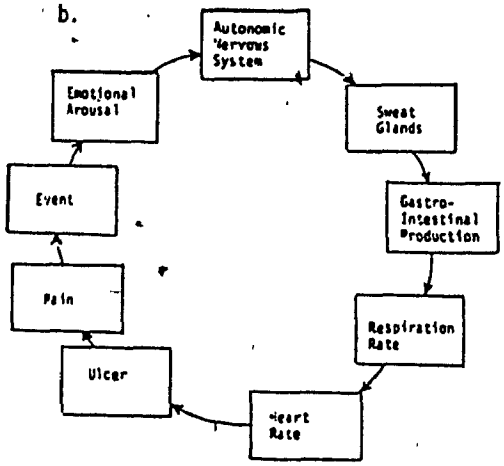
e. Not enough information in the unit to answer the question.

* 18. Which flow diagram represent the same cycle of pain for an ulcer?

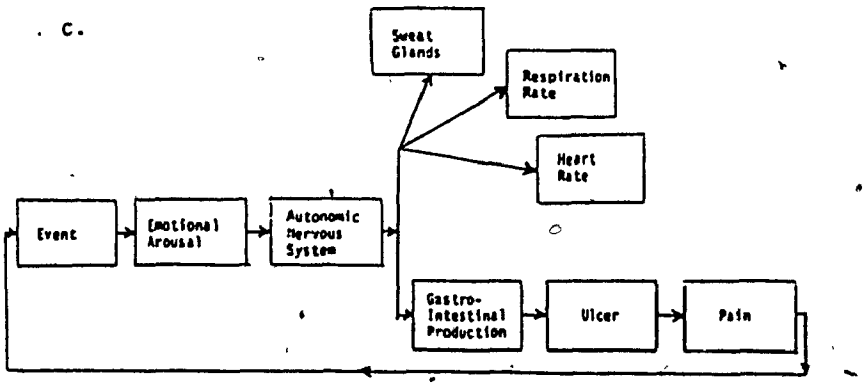
a.



b.



c.

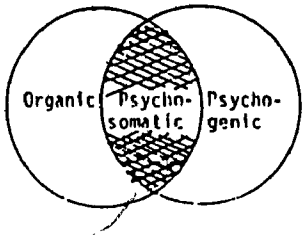


d.

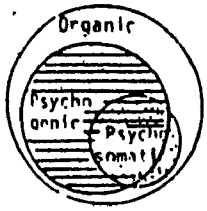
e. Not enough information in the unit to answer the question.

19. Which of the following diagrams represent the relationship among the three types of pain?

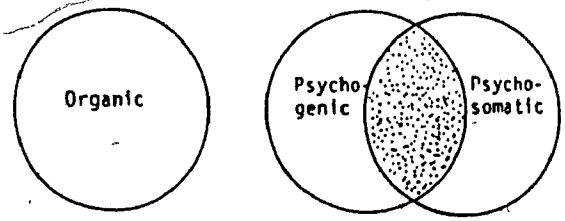
a.



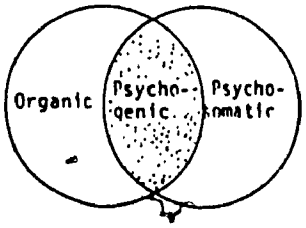
b.



c.



d.



e. Not enough information in the unit to answer the question.

20. The psychosomatic cycle:

a. must happen only once to produce an ulcer.
b. must happen everytime a stressful event occurs to produce an ulcer.
c. must happen all the time, whether a stressful event occurs or not, to produce an ulcer.
d. does not really have to occur to produce an ulcer.
e. Not enough information in the unit to answer the question.

21. Evidence that pain perception is 'learned' include:

1. The same psychosomatic pain is found in different members of the same family.
2. Girls and boys have different attitudes towards pain.
3. Different cultures have different attitudes towards the same painful situation.
4. An individual can be taught to control pain by psychological techniques.

a. 1, 2 and 3
b. 2, 3 and 4
c. 1, 2 and 4
d. 1, 3 and 4
e. all of the above

22. The 'felt-self' is located :

a. only in the right half of the brain.
b. only in the left half of the brain.
c. in a small strip of brain from ear to ear.
d. all over the surface area of the brain.
e. Not enough information in the unit to answer the question.

23. The physiological symptoms which accompany psychosomatic pain happpen is a predictable pattern. Which list below best represents that order for an ulcer?

a. emotion, pain, autonomic nervous system, heart rate, respiration rate, sweat glands, gastro-intestinal production, ulcer.

b. emotion, heart rate, respiration rate, sweat glands, gastro-intestinal production, autonomic nervous system, ulcer, pain.

c. pain, emotion, autonomic nervous system, heart rate, respiration rate, sweat glands, gastro-intestinal production, ulcer.

d. emotion, autonomic nervous system, heart rate, respiration rate, sweat glands, gastro-intestinal production, ulcer, pain.

e. Not enough information in the unit to answer the question.

24. 'Acute' pain and 'chronic' pain are different in terms of:

1. the length of time they last.
2. where they are located in the brain.
3. the physiological mechanisms they employ.
4. kinds of treatment they respond to.

a. 1 and 4
b. 2 and 3
c. 1, 2 and 3
d. all of the above
e. none of the above

25. Psychological components which influence the experience of pain are:

a. memory, attention, familial attitudes.
b. intelligence, attention, memory.
c. meaning, attention, familial attitudes.
d. racial attitudes, intelligence, meaning.
e. all of the above.

26. The neuron consists of:

a. nucleus, dendrite, axon, synapse.
b. nucleus, spinal cord, thalmus, synapse.
c. myelin sheath, dendrite, axon, nucleus.
d. synapse, axon, dendrite, thalmus.
e. not enough information in the unit to answer the question.

27. Dull and sharp pain are distinguished by:

a. the different parts of the brain in which they are located.
b. the type of neurons by which they travel.
c. the amount of pressure that is applied to the skin.
d. the amount of time the thalmus must be stimulated.
e. not enough information in the unit to answer the question.

28. Which of the following statements is true?

a. The site of psychosomatic and organic pain is always in the brain.
b. Relief for all three types of pain is the same - prescription drugs
c. Change in mood does not effect organic pain.
d. Onset of psychogenic pain is not clearcut.
e. Not enough information in the unit to answer the question.

29. The 'felt-self' consists of:

a. only the most important parts of the physical self.
b. only the internal organs such as the kidney, heart, etc.
c. the same parts as the physical self, but in the reverse order.
d. the same parts as the physical self, but in no special order.
e. not enough information in the unit to answer the question.

* 30. According to the description of the 'felt-self':

a. the joints are the most sensitive to pain.
b. the hands are relatively insensitive to pain.
c. the mouth is the most sensitive to pain.
d. nausea is located in the stomach.
e. not enough information in the unit to answer the question.

MULTIPLE CHOICE TEST

ANSWER SHEET

1. a b c d e
2. a b c d e
3. a b c d e
4. a b c d e
5. a b c d e
6. a b c d e
7. a b c d e
8. a b c d e
9. a b c d e
10. a b c d e
11. a b c d e
12. a b c d e
13. a b c d e
14. a b c d e
15. a b c d e
16. a b c d e
17. a b c d e
18. a b c d e
19. a b c d e
20. a b c d e
21. a b c d e
22. a b c d e
23. a b c d e
24. a b c d e
25. a b c d e
26. a b c d e
27. a b c d e
28. a b c d e
29. a b c d e
30. a b c d e

EVALUATIVE QUESTIONNAIRE

For each of the following statements, circle the number which best corresponds to how you feel.

		Disagree		Neutral		Agree
1.	I spent a lot of time examining the illustrations.	1	2	3	4	5
2.	I found the illustrations confusing.	1	2	3	4	5
3.	There wasn't enough time to study the illustrations.	1	2	3	4	5
4.	I found the pictures helpful in remembering the material.	1	2	3	4	5
5.	When I answered the multiple-choice test, I tried to visualize in my mind the pictures.	1	2	3	4	5
6.	I ignored the illustrations.	1	2	3	4	5
7.	I did not need to study the illustrations to answer the multiple-choice questions.	1	2	3	4	5
8.	When I answered the free-recall test, I tried to visualize in my mind the pictures.	1	2	3	4	5
9.	Generally pictures help people to remember things.	1	2	3	4	5
10.	Pictures are only good for decoration when you are trying to study something.	1	2	3	4	5
11.	I spent more time trying to study the text than the illustrations.	1	2	3	4	5
12.	If I had known in advance that some questions would refer to the pictures, I would have studied them more closely.	1	2	3	4	5
13.	Usually the text is more important than the pictures.	1	2	3	4	5
14.	I thought the pictures were interesting.	1	2	3	4	5
15.	I thought the pictures were too complicated.	1	2	3	4	5
16.	I have studied pictures like this before in other courses.	1	2	3	4	5