



Memory Enhancement in Adult Learners  
by ARTHUR LEE ALT

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Education  
Montana State University  
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Abstract:

Although investigations into human memory have been occurring for over one hundred years, the basic factors of memory are still not understood. Factors such as attention, acquisition and encoding of material, rehearsal, experience, and retrieval are important determinants of memory ability, but their individual importance changes with circumstances. Researchers have investigated each factor in memory in a variety of experiments, but little work has been performed on the possibilities of training adult learners to enhance their memory skills. Without memory, there can be no learning, but many students have never learned nor have been taught any methods for increasing their memory abilities. Therefore, the purpose of this study was to test the effectiveness of specific memory technique training on adult learners and to evaluate the possible successes of such training.

The design for this study was a case study which involved the collection of both qualitative and quantitative data. The primary methods for data collection involved an initial student memory evaluation by use of the SKILLS instrument, pre-tests and post-tests given before and after the memory training sessions, application of the Kolb Learning-Styles Inventory instrument for investigation of relationships between learning style and memory abilities, and a series of interviews and observations of the participants both during and after the training.

The results of this study indicated a number of areas that memory enhancement could be applied to adult learners. Test scores indicated significant improvements in ability to retain and recall all elements of the training. Interviews indicated the overall impression of memory training was that it was a definite success, although several of the techniques demonstrated were considered too difficult for regular use by the majority of students. The consensus of opinions was that more time was needed for the training program. Students found numerous advantages to the lessons, the most common being more free time and better grades. Disadvantages mentioned included the need for slower reading and the availability of too many techniques presented in the four week period.

The study indicates students with no prior exposure can benefit from memory enhancement training. Learning style does not adversely affect the way students learn memory techniques. The key elements in training memory in adult learners includes attention, motivation, structuring of materials, rehearsal, imagination, and the incorporating of fun elements into the interactive learning events. Memory skills can be taught and enhanced in adult learners at all levels of memory development.

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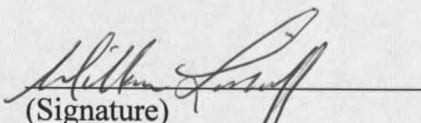
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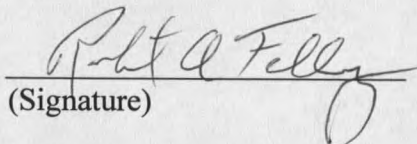
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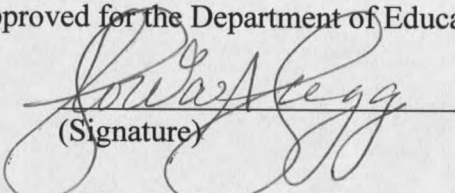
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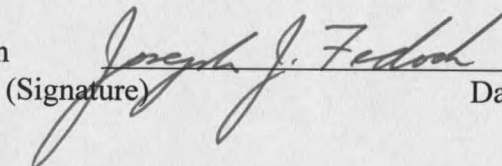
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## ABSTRACT

Although investigations into human memory have been occurring for over one hundred years, the basic factors of memory are still not understood. Factors such as attention, acquisition and encoding of material, rehearsal, experience, and retrieval are important determinants of memory ability, but their individual importance changes with circumstances. Researchers have investigated each factor in memory in a variety of experiments, but little work has been performed on the possibilities of training adult learners to enhance their memory skills. Without memory, there can be no learning, but many students have never learned nor have been taught any methods for increasing their memory abilities. Therefore, the purpose of this study was to test the effectiveness of specific memory technique training on adult learners and to evaluate the possible successes of such training.

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The results of this study indicated a number of areas that memory enhancement could be applied to adult learners. Test scores indicated significant improvements in ability to retain and recall all elements of the training. Interviews indicated the overall impression of memory training was that it was a definite success, although several of the techniques demonstrated were considered too difficult for regular use by the majority of students. The consensus of opinions was that more time was needed for the training program. Students found numerous advantages to the lessons, the most common being more free time and better grades. Disadvantages mentioned included the need for slower reading and the availability of too many techniques presented in the four week period.

The study indicates students with no prior exposure can benefit from memory enhancement training. Learning style does not adversely affect the way students learn memory techniques. The key elements in training memory in adult learners includes attention, motivation, structuring of materials, rehearsal, imagination, and the incorporating of fun elements into the interactive learning events. Memory skills can be taught and enhanced in adult learners at all levels of memory development.

## CHAPTER 1

## INTRODUCTION

Background

Memory problems have now been investigated for at least 100 years beginning with Ebbinghaus's published work in 1885 on remembering words and nonsense syllables. Prior to his work, Ewald Hering in 1870 (James, 1890) characterized memory as a general feature of organized matter, maintaining that since memory manages to survive sleep and other periods of unconsciousness, it cannot be associated simply with conscious thought. He felt it had to be considered an inherent capacity of the brain, following rules of regular material processes. More importantly, Hering considered memory to have a capacity that should be stimulated using memory enhancement techniques.

In reality, the use of memory techniques for handling accurate recall of vast amounts of materials go back as far as the ancient Greeks. Described by Cicero in 55 BC, the Method of Loci allows the learner to put information together via linking pictures of previously designated locations with newly formulated images of the material to be remembered. By making use of such a pre-arranged visual map linked to the objects to be recalled, an interaction -- but not necessarily lively -- situation is devised. This

mental construct was based solely on the learner's own knowledge base and experiences. This allows linking of new information with material already channeled into the brain. However, it has been found by psychological experimentation to be useless for most practical purposes in average persons (Ericsson, 1985) except for special individuals such as S.V. Shereshevskii who apparently used it extensively as a professional mnemonist (Luria, 1969).

Such techniques as the Method of Loci are typical of mnemonics, which are simply (but are not necessarily simple) cognitive techniques designed to assist the learner assimilate, form mental connections, and ultimately recall specific pieces of information without undue stress. Essentially, by assisting in organizing material, such memory techniques allow for greater comprehension, concentration, and remembrance of information and details. In many instances, those details may have virtually no real meaning (i.e., are abstract in conception) for the individual. As artificial memory producers, such techniques contrive meaning into topics that prior to the learning experience have no significant relevance for the learner.

### Mnemonics

There are numerous such well-known mnemonics, including the days in each month of the year; the lines and bars on a music score (EGBDF -- every good boy does fine -- and FACE); the stellar classification system based on temperature, color, and size (OBAFGKMRNS -- oh, be a fine girl, kiss me right now, smack!). Without mnemonics,

such material would be much more difficult to assimilate. That in turn necessitates much greater concentration and requires a vastly higher time expenditure, both of which are common problems for learners of all ages. The Law of Effect (Thorndike, 1898) is most applicable here and holds equally well for learning and memory. This law maintains that actions that lead to or cause immediate pleasure are learned, remembered, and quite often become habitual -- conversely, action leading to pain or discomfort are not remembered or are even suppressed!

In many memory systems, the guiding principle is to reduce the memorization process into a series of more meaningful elements, based on much smaller bytes of information in place of focusing on the entire picture. For example, Americans appear in general to be terrible at comprehending elements in paintings (M. Freel, Professor of Fine Arts, personal communication). Basically, they have learned to look at the entire work for analysis and not to reduce it down into more manageable, understandable units. This essentially says, "Get the general overview, ignore the finer details." Perhaps this also explains American students dislike for learning foreign languages (Lorraine, 1975) since a grasp of the nuances and the fine elements are required to become fluent in the language rather than simply rehearsing the larger aspects of a language.

Unfortunately, mnemonics seem to be of limited use primarily because many materials are not easily translatable into pictures. The average adult learner often makes use of repetition for learning materials. Study techniques are taught using that expedient along with such physical activities as underlining, outlining, highlighting, and

several others that perforce the student to engage more than just visual senses in the learning process. Numerous experiments have been designed and implemented involving the effects of repeated readings/listening/sayings. Most showed an associated negative accelerating learning curve as the accumulated effect of repeated repetitions on retention of information (Baddeley, 1976). Those experiments clearly showed that such repetitions did not guarantee at all that retrieval would be either clear, accurate, or effortless. Instead, what most often seems to occur is that the learner's success at recall is much more dependent on how well the learner places the new material in the existing framework of past experiences and knowledge. This process is referred to in several areas of science as embedding (Seamon, 1980).

### Memory Elements

To integrate material into memory, one of the basic requirements is the ability to concentrate. Gestalt psychology has tied this element of mental ability to recall via four principles that are fundamental to retrieval of information :

1. Every object perceived to be involved in a memory pattern stands out or is perceived against a simpler background (figure and ground principle);
2. All materials attempted to be committed to memory lend themselves to organization into distinct perceptual structures already known by the learner (segregation principle);
3. All materials only partially learned will, when recalled, be perceived as wholes (closure principle);
4. All materials which are strongly derived or emphasized, or formed in a more complete, detailed fashion will eclipse or override any less strong or less developed memory traces (good Gestalt principle). (Pickford, 1972, p. 280)

These principles imply that a fundamental element of learning is attention, or the ability to concentrate. Although studied diligently in the early 1900s (Titchener, 1900), attention disappeared as a suitable topic for study until it was revived as an important issue in 1958 (Broadbent, 1958). Since that time, over twelve theories of attention have been proposed. Several investigators have shown that more learning occurs when there is more total effort put on attention and that very dramatic increases in learning ability can be developed with practice (Fry, 1995).

Another primary element of memory is experience. John Dewey, one of America's best known educators, believed firmly that the education of people involved experiences and that such experiences formed the basis from which all original thoughts and material interpretations would come. In his perspective, all such experiences, particularly personally shared experiences, would act in a manner that provides infinitely more education than any learning occurring from simply reading a book. Intelligence, which is a prerequisite for memory ability, can be attributed to experience. However, the problem with intelligence is how the term is defined, measured, and quantified. Intelligence is defined in a variety of ways (Zechmeister, 1982) such as (a) the ability to carry on abstract thinking, (b) the ability to adapt oneself adequately to relatively new situations, or (c) the capacity to learn or to profit by experience. All of these have included within their structure the element of experience as a necessary part of memory/learning work.

An additional element of memory is forgetting. Such an event can take place under three possible causes (Baddeley, 1976). First, information may simply have been lost from whatever the brain used as a storage system. This could be due to decay of the mental construct (as happens in short-term memory), displacement of material by new information or memory patterns, or by modification by new information. Second, there may be lack of recall due to stored information being well-hidden. There is daily evidence of this, particularly when the right elements are not forthcoming as needed but show up in pieces later. Third, there may be an encoding deficiency where not enough information has been used to permit differentiation from what is already been placed in the brain.

Likewise, the element of aging presents another distinctive memory problem involving memory decline and decrease in the recall rate (Charness, 1985). Part of the supposed decline can be offset by knowledge garnished through later-in-life experiences. The slowing of the recall rate can be accounted for by the signaling processes within the brain and the sense organs becoming weaker with age. This can be overcome by people taking a greater amount of time during the learning period (Birren, 1977). For example, using six or seven digit numbers, recall by older people is found to be equal to that of younger people if increased practice recall via repetition is performed. This is also illustrated by the fact that materials well-learned or highly familiar events and skills such as bicycle riding are retained extremely well even into old age.

### Memory Investigations

As with many aspects of scientific investigation or computer-problem solving, a logical beginning would be to set up an algorithm. This seemingly innocent term refers to a predetermined procedure or strictly ordered sequence of clearly delineated instructions for carrying out in a finite number of steps the desired operation. This would contrast sharply with the mental state known as *anoesis*, literally the absence of thought. In this situation, consciousness is present, individuals still have sensations, but no thought is taking place. Experiments using positron emission tomography (PET scans) have revealed that in the brain the primary visual cortex is activated when subjects close their eyes and visualize objects (Kosslyn, 1995); when resting or not imaging, no activity is found. Moreover and most importantly, such mental processing involves depictive representations which are not solely language-like descriptions. Work has already been done on using oral traditions to shed light on how memory works by essentially asking how oral representations are used that for some reason are more memorable than others. This is Sperber's Law of Epidemiology of Representations, which holds that in an oral tradition, all cultural representations are easily remembered ones; hard to remember representations are forgotten or transformed into more easily remembered ones before reaching a cultural level of distribution (Sperber, 1985, p. 86).

Apparently, as Sperber points out, people are better at remembering a story than textual material. For example, everyone finds themselves accidentally recalling an

advertising jingle, including all the basic elements of words, rhythmic characteristics, colors, movements, and all sorts of basic substrates. Making things cute, or picturesque, seems to work to facilitate either recall or locking information into the unconscious mind. In this respect, it is highly likely that the total detail of the representation formulation is just as important as the content material to be memorized. This would fall quite appropriately into the subject matter of metacognition which deals with an individual's knowledge and ability to direct one's own thinking and learning processes. This includes (a) planning with critical analysis of the best or the most efficient method to use in dealing with a specific learning project; (b) monitoring or assessing how the learning is proceeding throughout the course of the project; and (c) adjusting the level or technique to improve one's actions in the learning situation, using some form of evaluative feedback to alter the strategy for the better. These three relate equally to the memory skill developed since they are all sustained by interaction with how the memory patterns are organized and what techniques are being used to develop and reinforce the mental images in the first place.

### Memory Processes

Although the biological basis for memory is poorly understood, it is clear that two processes which are somehow connected, are involved. The first process must be acquisition or the learning of new material. This new material can be either a skill or information. The second process is called retrieval which is the later recall of that datum.

The connector needs to be some change in the brain properties itself, either locally or spread over a larger area to act as a storage center for the acquired datum. That stored piece of information is now known as an engram, or memory trace, a convenient term for a faculty which is totally unknown.

Much research has been done on memory and particularly on biological bases (Carlson, 1991; Kosslyn, 1992; Kosslyn, 1995). However, very little research has been conducted on techniques of improving memory abilities, particularly in those learners who have low skill levels in recall and poor metacognition levels in the first place (Fry, 1995). What techniques are applicable to invigorate low skill levels? Do some techniques have greater potential for one type of material compared to another -- for example, does one technique work better for memorizing foreign language words and not for retaining a listing of activities for a day or for internalizing the relevant points from a textbook on chemistry? Are the techniques difficult to teach, or are they simple enough that they could be started at a much lower level than adulthood? Does one's range of life experiences affect the ability to learn such techniques? Can such memory skills be taught with a modicum of esoteric terminology without a necessary scientific understanding of how the brain system works or how memory patterns become encoded, switched, or retrieved? Can such memory techniques be applied to rigorous, detailed material or are they useable only on listings or generalities? Are those learners with poor memory abilities also handicapped with poor motivational skills and thus basically unaware of and lacking any control over factors motivating and directing their own learning? On a

generational note, do students who are older and from an earlier educational system show more memory abilities than do younger students? Are there indications that memory skills are currently being taught in the pre-collegiate educational systems? Does poor memory skills have a significant effect on the daily lives of people in their own society? Are memory skills more prevalent in one sex than in the other, or in one age grouping compared to others? Thus, numerous unanswered questions exist concerning the relationship of memory skills with other life factors involved with adult learners.

### Problem

Without memory, there can be no learning. Yet, many students have never learned nor have been taught any methods for increasing their memory abilities. Many students learn by repetition or repeated readings with the formation of random recall patterns in their brains.

It has been known for years, particularly among college students, that the one effective mechanism for learning and recalling important (i.e., testable) material is by understanding it. The problem, however, quite often revolves around the necessity of formulating memory traces on information that is not particularly understandable nor is necessarily visualizable. The problem for students, and in particular for those not comfortable with memory skills, is to be able to develop their own techniques or to use modifications of ones learned by prior experiences to fit the current circumstances. Unfortunately, those who are being required to memorize and internalize whole bodies of

unfamiliar and perhaps highly detailed material and who are most in need of the abilities requisite to developing such memory skill techniques are those less likely to either have the techniques already on hand or to be able to modify them intelligently to fit the circumstances based on the advantages or perceived disadvantages of each technique.

In experimental studies, research has concentrated on questions dealing with what and how much is learnable, with how quickly materials can be integrated into the stored body of knowledge, and with the time intervals over which different elements can be retained (Zechmeister & Nyberg, 1982). Outside the realm of memory techniques, there have been extensive studies performed dealing with brain systems on the biochemical, physiological, and cellular levels (Seamon, 1980). However, the application of specific memory techniques such as the Method of Loci have been virtually ignored. It is in these techniques that students, and particularly those of low memory skills, may find a means and tools to re-implement their own metacognition and memory abilities.

#### Purpose

The purpose of this study was to test the effectiveness of specific memory technique training with students possessing various levels of memory skills and to evaluate the possible successes of such training. This involved identifying student memory skills levels at the beginning of the instruction and the memory techniques they have assimilated through prior education and currently use. Students were identified and grouped according to their use of memory learning strategies. Then, by using pre- and

post-testing evaluations, the ability of students to gain from such a course on memory improvement was investigated, including the application of a variety of memory techniques and stimulants to problems of concentration, comprehension, short-term and long-term memory, and structured recall.

### Significance of the Study

For adult education, there are many reasons such a study should be undertaken.

Among those reasons are:

- (a) Poor memory skills lead to a great deal of wasted energy, resources, and time for people who are forced to habitually repeat and relearn materials over and over;
- (b) Poor memory skills lead to loss of self-esteem and a further reduction in the interest of learning, forcing such people further behind in learning skills and knowledge necessary for the future;
- (c) Investigation of memory techniques that are teachable would provide a tremendous accessible tool for dealing with learning problems based on either poor motivation, metamotivation, or memory skills;
- (d) There is a need to develop in the educational system a basic set of techniques that *all students* can acquire to enhance their learning ability;
- (e) The development of a series of memory techniques would allow students at any level to become expert in an area at a much quicker pace with subsequent benefits in

learning and reasoning ability, in time saving, and in the interest to expand learning into additional fields of study;

(f) The techniques would assist learners into a program of life-long learning with the reduction of stress commonly associated with learning new materials, stress due to the lack of adequate memory techniques;

(g) It may help reduce the belief commonly held in America that learning is a strain (Holt, 1964) which involves hard work and suffering (the basic old Protestant work ethic) and could replace it with an understanding that learning can be enjoyable and contribute to a more positive outlook;

(h) It should show how to enhance the joy of learning by making what was once difficult to make in mind become easier and more retrievable; and

(i) Most importantly, such studies should show how to stimulate the brain like a gigantic muscle -- the use it or lose it syndrome -- and that the process can be more efficient and durable and can last throughout one's life without deterioration unless changed by desire or deliberate misuse such as drugs.

#### Researcher Background

This study was developed as a result of the experiences of the researcher in teaching various sciences to predominantly non-science oriented students with a well-established fear or dislike of any form of scientific endeavor. In the practice of teaching over twenty years at the college level, it has become apparent that one of the major blocks

students are forced to quite often overcome is a lack of any memory skills. It would seem justified to believe that students coming through the American education system should have learned how to learn effectively, how to memorize materials and internally organized them into relevant, easily retrieval forms. This, however, has not been observed by this researcher.

In place of ease of memorization, comprehension of materials, and learning of concepts, the researcher has noted a general lack of ability, particularly in encoding the material into long-term memory and in the use of any sort of critical thinking process involving the use of such stored material. This inability to even think about what they are doing, either as metacognition or metamemory, has made the college experience for many students a much more challenging set of events. The challenge is one dictated by the limited amount of time available for reading, re-reading, and re-reading, in the hopes material will stay in place in memory long enough to pass required examinations.

Whatever the problem, whether it be lack of confidence in oneself, lack of study skills, or the total lack of any training on memorization skills and use of memory aides, this researcher has found over the years that even a minor amount of training in developing memory abilities pays tremendous dividends for the individuals involved, in particular in terms of self-confidence, reduction of time necessary for studying, and a more positive outlook on general study skills. Such training, while not entirely eradicating the problems that go along with poor study habits or lack of higher thinking skills, would go a long way in reducing student frustration with the college learning

experience, changing the learning experience to one of enjoyment, comprehension, understanding, and reducing the fear level that students will, before they are given instructions, approached new material.

### Research Questions

The ability to influence the memory, retention, and recall of information is assumed by all teachers at every grade level of instruction. However, very little formal instruction is provided to maximize a student's memory abilities, the long-term retention of material, or the comprehension level of the materials being studied. Therefore, the primary questions of this study are:

- (1) What memory techniques are learned most effectively by students who enter a program of training already possessing diverse memory skills?
- (2) Can memory skills be taught directly such as skills like typing?
- (3) What effect does practice have on the development of such memory skills?
- (4) What memory techniques are learned most effectively by students who have low memory skills initially?
- (5) What role does motivation play in developing memory abilities, particularly in students who enter the training program with low memory skills?
- (6) How do users with different cognitive styles react to memory training?
- (7) Do learning styles correlate with ability or inability to learn skills through a memory training program?

## Definition of Terms

### General

Acquisition: The means by which a learner encodes, or puts information, into memory storage. The term refers to all the subsystems responsible for acquiring information and placing them into short-term memory for further processing (Houston, 1991).

Chunking: A memory process in which a number of related items are stored and retrieved as a unit in order to facilitate memory. The subsystem involved allows for storage of massive amounts of material in memory in an organized fashion (Miller, 1956).

Cocktail Party Effect: A documented effect in which information that is being attended to will be remembered, whereas information that is not being attended to will be forgotten or not learned. The phenomenon is described by the way people switch their attention among different simultaneous conversations at large parties. The effect itself necessitates at least two modes of action for the attention system (Buzon, 1989).

Cognitive Science: The field that explores the mechanisms through which people acquire, process, and use knowledge. It's importance lies at being at the basis for the educational practice. The interplay between Cognitive Science and other fields of

scientific research have led to major discoveries on the operational processes involved with the diverse systems of memory in the human brain (Bourne, 1979).

Elaboration: This process refers to the establishing of linkages between new information and previously stored information in long-term memory. Through the process, more neural pathways are created with previous existing memory traces, allowing for clearer and easier retrieval of information (Walker & Jones, 1983).

Encoding: Any mental operations performed on information arriving in the sensory system that form memory traces of that input. The material is acted on by the Encoding process while in the short-term memory system. Numerous factors then determine if the established traces will be re-localized into the long-term memory system (Thomson & Tulving, 1970).

External Memory Aids: The deliberate use of lists, timers, calendars, and similar devices to remind an individual to do something at a particular time. Such assistance does little for the development of memory skills (Lorayne, 1975).

Interference Theory of Forgetting: A theory of how people forget based on interference or displacement of the to-be-remembered items by other material that has been previously or subsequently learned. The theory is in direct opposition to that of gradual decay, where memories are lost or modified over time as the memory traces wear out due to age or non-usage (Eysenek, 1977).

Internal Memory Aids: Mnemonic devices or memory aids that rely on plans or strategies to make retrieval easier and more likely. Such devices are either installed prior to a memorization event in the brain, or they are used as convenient association points to hook to the information while it is being converted into a memory trace (Houston, 1991).

Learning: This is the process whereby knowledge is created through the transformation of experience (Kolb, 1984). Intimately related to memory, the processes of Learning are diverse in nature, but all revolve around the establishment of a basic core of knowledge placed in the brain for future usage.

Learning Environment: The environment of learning that plays a premier role in transforming knowledge and experiences into viable memory traces. These include affective, perceptual, symbolic, and behavioral complexes. Numerous factors within the environment play large roles in the establishment and retention of memory traces (Baddeley, 1976).

Learning Strategy: The set of tactics or methods an individual uses in dealing with any particular learning task. Strategies will vary from task to task. The type of Learning Strategy used can range from the simplest identification ones to those of higher order thinking, including critical thinking, synthesis of concepts, problem-solving, and scientific evaluation (Conti & Fellenz, 1991).

Learning Style: This deals with how an individual handles new information, events, or circumstances in the present environment. It also refers to the particular mode of learning that an individual prefers (i.e. visual, auditory, kinesthetic) when new material is being presented (Kolb, 1985).

Long-Term Memory: The memory system, of unlimited scope, that retains information over long retention intervals. Among the unanswered questions is how material gains access to the storage system, and why do some memories vanish after a brief time interval but others are seemingly permanent (Waugh & Norman, 1965).

Memory: A system of the brain that allows for the acquisition, encoding, temporary storage, and long-term storage of information. Although often attributed to higher developed organisms only, many of the subsystems of memory are found in the invertebrates. Occurring in several alternate forms, the processes acting within the subsystems are a major area for study in the cognitive sciences (Anderson, 1983).

Metacognition: The term refers to the ability to know about and direct one's own thinking and learning processes. Metacognitive skills include the ability to predict the results of one's own problem solving actions, to check the results of one's own cognitive processing, to monitor progress towards a problem solution, and to test one's actions and solutions (Brown & DeLoache, 1978).

Metamemory: An individual's knowledge about how his/her own memory system works, including components of organization, external aid usage, and memory application. In detail, it involves the structuring of information so that the material will be best stored, retained, and retrieved, using either external aids such as writing down lists, or internal aid application, such as the use of mnemonics or mental images (Anderson, 1983).

Mnemonics: Memory aids or techniques that are utilized to improve memory. They range from the simplest tying-a-string-around-a-finger to highly complex image formation systems that allow for inputting in a recoverable fashion the most abstract of concepts (Houston, 1991).

Recency effect: The concept that the more recent the memory, the better it is (Cohen, 1981). Part of the effect suggests that the time lag between repetitions or rehearsals of material is not important. In general, the effect depends greatly on the attention level expressed during the learning period (Glanzer, 1972).

Retention: The storage of information into the memory code from experience until it is needed again. This means that Retention problems are significant in being problems of storage of adequately coded information. Key elements include attention focused on the material at the time of memorization, the formation of memory traces, and the elaboration occurring during the encoding process (Houston, 1991).

Retrieval: The act of recalling or remembering information that has been previously stored in memory. The system is responsible for locating, analyzing, synthesizing, and elaborating material in response to requests supplied to long-term memory. Retrieval only works well when the information is clearly marked or has been adequately associated with other materials present in the brain (Baddeley, 1986).

Schema: This is what allows automatic processing to occur in long-term memory (Neisser, 1976). It is the coherent framework that has been derived and interpreted from past experiences. Evidence suggests Schema change with time and experience and organizational structures imposed from outside the brain.

Short-Term Memory: The limited capacity memory system that stores memories lasting up to approximately one minute. Also often called working memory, the system is strongly tied to the attention, acquisition, and encoding systems (Waugh & Norman, 1965).

State-Dependent Memory: The ability to recall certain events or information is facilitated when individuals are in a mood or state of recall that is similar to the one they were in during the time of original acquisition. Apparently the easiest memories to retrieve are found when the individual is in the same state as when the memory experience occurred originally (Houston, 1991).

von Restorff Effect: The perceived effect where one item differing greatly from the others in a list is remembered better (Cooper & Pantle, 1967). Any item with a clearly distinguishing characteristic will be remembered at the expense of more similar items. The counterpoint to the effect is that memories tend to be short and easily lost if there is not numerous associations made in the brain with already well-remembered materials.

### Training Program Terms

Creative Mind Maps: Mental maps that have a centralized focal point representing the major topic from which pathways stream out dealing with the additional concepts or ideas relevant to the subject. The pathways are intermingled with key words, concepts, or images. In advanced mathematics such diagrams are called Tree Diagrams.

Copy-cat Words: Words that are used to make mental images that look like the word or idea to be remembered. For example, for bork one might use cork, book, or bore to formulate a picture.

Homeroom Map System: Originally known by the Romans as the Method of Loci, the technique uses a well-known room in the learner's own home as a focus for locating pictures of information to be retained. By associating information with objects already located in the room, the information becomes much more organized and systematically retrievable.

Letter Alphabet: Memory technique associating each letter of the alphabet with a picture and a numerical value forming a second picture. For example, "T=turtle = 20 = Nose (by the Number Alphabet System). So turtle is incorporated into a picture hanging onto a nose. Useful for memorizing mathematical formulae, chemical reaction mechanisms, most interrelated number-letter quantities.

Make-believe Pictures: Process of making pictures that are familiar to replace words or ideas that are too abstract, nonsensical, or impossible to easily make mental images of. Works extremely well for foreign languages and specialized terminologies. For example, in place of schwarzkopf, one might use quarts coughing tied to the picture of the real meaning of the German word.

Memory Chart: Technique using a box chart with the Letter Alphabet on one axis and the Number Alphabet on the other. Data are located in the appropriate squares for retrieval in relation to each other. Useful for maps, tables, graphs, and any material in quantity that can be placed in a chart format.

Number Alphabet: A vastly useful system that uses pre-assigned letters and associated words for numbers. This allows information to be memorized in order, and allows for the handling of numbers in the forms of dates, addresses, telephone numbers, or any numerical data. For example, "2" is associated with the letter "N" and the word

“Noah”, while “22” would be associated with the letters “NN” and the word “Nun”. Any number can be immediately converted into visual mental images of corresponding words.

Picturization: A fundamental process of visualization in which the learner transforms every element desired to be remembered into an active visual mental image. Elaboration processes include color enhancement, forming ridiculous and exaggerated images, adding elements of motion and 3-dimensionality.

Recall Pattern: Technique for placing materials to be retained in a logical format that allows retrieval from front-to-back, back-to-front, or working from the middle in either direction. Typical patterns include circular, trellis, diagonal, and random.

Rhyming Order System: This memory technique uses rhyming words corresponding to numbers to order memorized material. For example, learners often use sun as the rhyme for one, so the first information to be remembered is associated with an active picture of the sun.

Shapely Figure System: Memory system that uses the shape of a number to make a picture which can then be attached to material to be retained in numerical order. For example, the number two often uses a duck or swan in the picture to locate a bit of information in the second position.

Storyline Process: This process is the linking of mental images together to turn information to be remembered into a story or movie, incorporating all the pictures into an action sequence. The idea of a Storyline allows associations to be formed in the brain that allow for more rapid and easier recall.

#### Limitations

All participants for this study were chosen from the local student population enrolled in either the University of Great Falls or Montana State University- College of Technology. It is possible that students in other regions may react differently to memory instruction.

#### Delimitations

Although the participants chosen for this study were all students, many were also involved in different professions. These professions included college professors, college administrators, medical specialists, Air Force officers, nurses, and blue-collar workers. Several participants were students having never worked outside the school environment, while others were currently full-time students having worked in some profession prior to returning to school.

Assumptions

It is believed that the individuals selected for this study represented a fairly broad spectrum of students involved with the use of memory skills, both in terms of their original ability and their prior knowledge of memory techniques. Moreover, because of the wide range and diversity of learning styles that were represented by the participants, it is believed that a typical range of approaches to memory use, with associated problems and beliefs involving poor memorization abilities, was present in the study participants.

## CHAPTER 2

## LITERATURE REVIEW

Learning

What learning entails is a large question for researchers in education. Quite often it is continual, effortless, inconspicuous, complete, commonplace, ordinary - it occurs so often that we rarely think about it while going through daily life. If anything, learning is not difficult (Holt, 1964, p. 38), since it often doesn't even require deliberate motivation, so that often we learn without knowing that we are learning. Formalized education and schooling has indeed made this idea seem somehow strange, in that many educators consider learning to be sporadic, difficult, necessitating major effort, requiring special motivation, incentives, and rewards (Holt, 1964, p. 39). What distinguishes these two views? Learning is easy when it is part of the normal flow of events in which a person is involved, when sense is made of what is being done and when the individual's brain is operating on its own affairs. Learning becomes difficult when it is deliberate, done against the flow of events, and made the specific focus of attention, when it is oriented to some future goal rather than to present interest: in other words when it is forced. Learning that is driven by determination and effort is paradoxically likely to be the least efficient learning of all (Holt, 1964, p. 40).

Materials must be learned in different ways. For example, recall of non-word material is done differently than for word-like materials (Gathercole, 1995). Ausubel points out that different tasks have different requirements (Ausubel, Novak, & Hanesian, 1978):

Potentially meaningful learning tasks are, by definition, relateable and anchorable to relevant established ideas in cognitive structure ... Rotely learned materials, on the other hand, are discrete and relatively isolated entities that are relateable to cognitive structure only in an arbitrary, verbatim fashion ... They are learned and retained in conformity with the laws of association. (p. 144)

In Ausubel's theory of assimilation, meaningful learning only occurs if the material is presented in such a way that it makes itself potentially meaningful, and only if the learner has a necessary anchoring set of ideas and knowledge that allows linkages to be established with the new material.

Memory and learning are intimately related. Based on extensive clinical neurological investigations, Nielsen (in Squire, 1987) found two forms of memory involved in learning. The one form involves memories of life experiences centering around the person himself and basically are focused around the element of time. The other type includes memories of intellectually acquired knowledge that has not experienced. It has been learned by study and therefore is not personalized unless done by the learner.

On the basis of the interaction of learning and memory, learning can be defined (Kolb, 1984) as the process whereby knowledge is created through the transformation of

experience. This emphasizes several aspects that are critical to the investigation of memory. First, there is an emphasis on the process of adaptation and learning, as opposed to content or outcomes. This is relevant because memory can be shown to be a successful process or structure building new materials on previous learned ones, allowing for the organism to adapt to changing conditions or requirements in the environment. Second, knowledge is a transformation process, continuously created and recreated, not just a collection of material to be acquired or transmitted. For memory, the essence of this is that memories change, are augmented or depleted, depending on the circumstances of the environment and individual needs. Third, learning transforms experience in both objective and subjective forms, and it is these experiential changes that become fixed in the brain as memory traces. Lastly, to understand learning, and therefore memory, it is essential to understand the nature of knowledge, and vice versa.

A major approach to this study and understanding of memory is that of cognitive science, dealing with, among other things germane to memory studies, information processing, knowledge types and knowledge representation. According to information-processing theory, the central concept of cognitive science, humans are symbol or information processors; input enters the system in the form of symbols or symbolic representations, activates particular cognitive processes, and results in physical or mental actions. Those actions occur as individual components of knowledge are processed. From cognitive research, there are three types of knowledge identified: (a) declarative, about the world and its properties; (b) procedural, on how to do things; and (c)

metacognitive, about one's own knowledge, skills, and abilities. All three are important for they are not only apparently entered, organized, and stored differently in memory, but are stored in a number of possible representational forms (McGilley, 1994, p. 5).

Experts and novices are differentiated in a knowledge domain not only through the amount and origination of knowledge, but also by what is chosen to be represented in the first place. Novices connect pieces of domain knowledge in terms of surface-level features, while experts organize information in terms of deeper level, conceptual features (Chi, Feltovich, & Glaser, 1981).

The beginning of learning theory as applied to memory problems occurred in the 1870s with work performed by Herman Ebbinghaus (1885). He used the study of nonsense syllables as the means of investigating learning. Hundreds of similar studies have been undertaken since his pioneering work. These studies were oriented in such a fashion that the learning was contrived (or forced), the most difficult type of learning situation. What became apparent quickly was that learning and/or memory was easiest when external control was relaxed, when individuals were permitted to take charge of their own learning: more simply, learning became prolific when it was unfettered in any way, when it was not forced (Holt, 1964, p. 42). Since memory involves experiences in one form or another, the entire process became one of experiential learning. Such learning or memory activities involves four adaptive learning modes (Kolb, 1984): (a) concrete experiences, (b) reflective observation; (c) abstract conceptualization; and (d) active experimentation. The basis of the learning/memory process lies in the

transactions among those four adaptive modes and the ways they are forced to interact as material is assimilated. Knowledge stored in the brain results from the combination of experiences for the individual. This is transformed into a viable memory trace.

The environment plays a premier role in such experience/transformation relationships. Several types of environments are possible:

(a) affectively complex situations: cases where the emphasis is on experiencing what is actually to be studied or investigated. Learners would engage in activities that simulate the world conditions, with the information generated most often of current or immediate use;

(b) perceptually complex situations: ones where the primary goal is to understand something, to identify relationships between concepts, and the like. The learner is encouraged to view the topic matter from different perspectives and in different ways;

(c) symbolically complex situations: ones where the learner is involved in trying to solve a problem for which there is usually a right answer. The information is often abstract, in that it is removed from the present, and the learner is guided and constrained by externally imposed rules of inference, which need to be recalled via memory;

(d) behaviorally complex situations: those where the emphasis is upon actively applying knowledge or skills to a practical problem. Here completing the task is essential.

Learning environments vary in the degree in which they are oriented to any of the four pure types. In fact, quite often the learning arena is a mixture of the above styles.

But it has been well established that during the learning process, wherever it is occurring, the human brain primarily remembers (Anderson, 1983):

- (a) items from the beginning of the learning period (the “primacy effect”);
- (b) items from the end of the learning period (the “recency effect”);
- (c) any items associated with things or patterns already stored, or linked to other aspects of what is being learned;
- (d) any items which are emphasized as being in some way outstanding or unique;
- (e) any items which appear particularly strongly to any of the five senses;
- (f) those items which are of particular interest to the person.

### Metacognition

Metacognitive skills include the ability to predict the results of one’s own problem solving actions, to check the results of one’s own cognitive processing, to monitor progress towards a problem solution, and to test one’s actions and solutions against the realities of the larger world. These aforementioned skills are “the basic characteristics of efficient thought” (Brown & DeLoache, 1978, p. 15). In many models of thinking and learning, the framework is conceptualized as consisting of three levels of usage: (a) individual skills (such as memorizing, observation-making, hypothesizing); (b) organized strategies for use of skills (such as problem solving techniques or processes of inquiry); and (c) metacognition (the ability to think about and modify one’s own thinking). An essential element becomes the attitudes one holds about thinking (or

memory), since those attitudes are conceived as being critical to an individual's ability to think or memorize effectively.

John Flavell (1979) defined metacognitive knowledge as "that segment of your (a child's, an adult's) stored world knowledge that has to do with people as cognitive creatures and with their diverse cognitive tasks, goals, actions, and experiences" (p. 906). Brown (1981) breaks it down even more, into two types of metacognition: (1) knowledge about cognition and (2) regulation of cognition. The first type includes such things as knowledge about one's own cognitive resources, and knowledge about how capable the learner deals with demands of these learning situations with the available resources. The second type "consists of the self-regulatory mechanisms used by an active learner during an ongoing attempt to solve problems" (Brown, 1981, p. 21). This includes planning one's next moves, checking outcomes of any strategies used, monitoring the effectiveness of attempted actions, and evaluating strategies.

When the concept of metacognition is applied to memory, the term is labeled metamemory. The principle defining attribute of this cognitive orientation (Marfo et al., 1991, p. 77) to learning/memory is the proposition that learning is an active, constructive process involving the learner's use and management of internal cognitive processes to acquire, store, retrieve, and apply knowledge. Researched extensively since the mid-1970s, it includes the cognitive processes of encoding, retrieval, rehearsing information entered in STM, searching for stored information, and using learning strategies, such as item clustering and elaboration (Baddeley, 1986). The most important point of this

research is that studies have shown that instruction in the use of the components of metamemory have led to improved cognitive performances, including: reading (Brown, Campione, & Day, 1981) and thinking and reasoning (Meichenbaum, 1977; Sternberg & Weil, 1980; Light, 1991). Much of the differences between good and poor learners can be attributed to metamemory. Bransford (1979) summarized it as

...Effective learners know themselves what they need to know and do in order to perform effectively; they are able to monitor their own levels of understanding and mastery. These active learners are therefore likely to ask questions of clarification and more efficiently plan their study activities. Such activities are quite different from passively accepting (yet momentarily actively processing ) the particular information that a person or text presents. (p. 248)

One of the important elements of memory that relates widely to metacognition and memory is based on the fact that the brain has no direct contact with the physical world; it senses the world by use of neural activity or clues. The brain does not respond to the world. Instead, it creates the world, in a sense making it's own reality based on the neural input. Likewise, the brain only responds to the immediate present; the past and future are both products of the brain's ability to handle the incoming clues. The brain can not be thought of as an information-processing device, since it actually imposes meaningfulness on the world. The memories stored in the brain are by-products of experiences the individual has had. This constant formation of reality can be used to explain why things are forgotten, why memories become modified over time, and why some pieces of trivia are remembered long after more substantive things are dropped from the storage area.

Psychologists have pointed out that memory is constructive: an individual never recalls exactly what actually happened, but only what the person thinks must have happened. Imagination is inextricably mingled with memory and with the individual's understanding of the past. Without imagination there would be no memory at all! As Bruner (1986) says in Actual Minds, Possible Worlds, "Imagination is the basis of all science, literature, and philosophy - and of everyday experience and the "self" as well" (quoted in Gagne, 1980, p. 52). The role of imagination in memory is so great that it is summarized here.

### Imagination

Imagination is the dynamo of the brain, the source of all our intellectual energy and creativeness. As long as the imagination generates its power, individuals remember, understand, learn, and think, smoothly and efficiently, at least within the constraints established by the imagination itself. But when there is an override on the imagination, when thinking is directed in some other way, such as due to an arbitrary decision by oneself or someone else, then all operations fail. The brain loses its integrity (in both senses of the word), it is thrown out of gear. Every facet of thinking is shattered (Holt, 1964, p. 54).

## Intelligence

Intelligence is essential to imagination and to learning, but how essential is uncertain. It is assured that any sort of difference between individuals in ability, personality, or motivational characteristics can, and often do, serve as sources of aptitude for learning (Cronbach, 1977). A useful definition comes from Binet and Simon: "A fundamental aspect of intelligence, the alteration or lack of which is of the utmost importance for practical life. The faculty is judgment... practical sense, initiative, the faculty of adapting one's self to circumstances. To judge well, to comprehend well, to reason well, these are the essential activities of intelligence." (1916, p. 9). A similar view is Wechsler's: intelligence is the "aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with the environment" (1944, p. 3). Both of these views, to be useful, necessitates the ability of memory, coupled to imagination and intellect, for the individual organism. The past two decades have shown a tremendous resurgence of interest in the enhancement of intellectual performance. Dominated by the information-processing approach, research has been applied to verbal ability, reasoning ability, spatial ability, and memory ability (Sternberg et al., 1982, pp. 155-156). Since memory is the key to understanding how each of those abilities work, especially over a long time span, memory development has become an active area of research.

## Learning Styles

Learning styles theories deal with the mechanisms that individuals use to assimilate and process information. Numerous theories on learning styles have been developed, each centered on a particular idea. Theories describing the cognitive personality included those using the Meyers-Briggs Type Indicator and the Witkin's Embedded Figures test. Models oriented more towards the effect of environment on learning preferences include, for example, the Dunn LSI. The third group of theories include ones oriented towards ways the information being acquired by an individual is processed. The most famous of the instruments in this latter category is that of the Kolb Learning Style Inventory.

The Kolb Learning Style Inventory (LSI) was created to assess an individual's orientations toward learning (Kolb, 1981). The four basic learning modes Kolb derived were defined as:

- (a) an orientation towards concrete experience - this focuses on being involved in experiences and dealing with human situations in a personal way. It strongly emphasizes feelings as opposed to thinking;
- (b) an orientation towards reflective observation - this focuses on understanding the meaning of ideas and situations by carefully observing and impartially describing them. It emphasizes understanding as opposed to practical application.
- (c) an orientation towards abstract conceptualization - this focuses on using logic, ideas, and concepts. It emphasizes thinking as opposed to feeling.

(d) an orientation towards active experimentation - this focuses on actively influencing people and changing situations. It emphasizes practical applications as opposed to reflective understanding.

The norms for the scores of the LSI were developed, along with reliability and validity data using a wide variety of individuals and occupations (Kolb, 1981). From his study, he derived four aspects of what was termed the Experiential Learning Model: these aspects included Concrete Experience, Observations and Reflections, Formulation of Abstract Concepts and Generalizations, and Testing Implications in new situations. Any individual, in any situation involving learning, will use some combination of these approaches, the amount of each used depending on the personality of the individual and the particular learning situation.

The learning styles as envisioned by Kolb then come from the Experiential Learning Model. The tasks used by individuals to understand new materials include: Concrete Experience, Abstract Conceptualization, Active Experimentation, and Reflective Observation. In Kolb's Learning Style Model, the tasks are placed on a normal pair of Cartesian coordinate axes for graphing purposes. The vertical axis has, on the top, the method of learning by Concrete Experience, while directly opposite is that of Abstract Conceptualization. On the horizontal axis is place, to the left side, Reflective Observation, while the right-hand side is viewed as Active Experimentation.. For each individual, there will be varying combinations of each of the four learning qualities, so that never will an individual fall directly on either of the axes.

The intersection of the axes provided the quadrants that correspond to the learning styles of Kolb. These distinct styles included: Convergents, Divergers, Accommodators, and Assimilators. To see which propensities the learner has, one needs only look to each axis for the proper quantification and term (i.e. Active Experimentation, Abstract Conceptualization, Concrete Experience, or Reflective Observation).

It should be noted that, in terms of intellectual ability which may have great importance in memory skills, there have been no studies finding a relationship between intelligence and results on learning styles. However, in terms of academic backgrounds, it was noted by Kolb (1981, pp. 240-244) that there did seem to be a tendency for individuals working in the same disciplines to have similar learning styles.

### Memory

Although no one has yet seen an actual memory stored in the brain, the idea of memory has tremendous importance in the area of learning, skills development, and knowledge acquisition. The reality is that nothing is ever accomplished without memory. The ability to store knowledge is the major factor allowing for the assimilation of basics which are linked together to set the stage for subsequent learning events. In effect, remembering, understanding, and learning all involve thinking. The basis for thinking is memory; try thinking about anything without using words, pictures, or sensations that have already been accumulated about that subject, and the impossibility of the task becomes apparent immediately. The essential factor is memory ability.

When material is learned, changes occur in the brain structure. It has not yet been established what those particular changes are. Most recent work suggests there are various types of memory changes corresponding to differing modes of memory (Baddeley, 1992). For example, in the system known as long-term memory possible divisions include (Squire, 1987, p. 169):

(a) fact memory - deals with memory activities including declarative memory, explicit memory, memory for "knowing that", cognitive mediation, conscious recollection, elaboration, memory with record, autobiographical memory, representational memory, vertical association, locale memory, episodic memory, and working memory;

(b) skill memory - deals with memory activities including procedural memory, habit, implicit memory, memory for "knowing how", semantic memory, skills memory, integration complexes, memory without record, perceptual memory, dispositional memory, horizontal association, taxons, semantic memory, and reference memory.

Due to interdisciplinary research much is known about how memory works now, compared to earlier in the twentieth century. The disciplines involve crossing behavioral neuroscience, cognitive science, developmental biology, social personality studies, and molecular biology. Fields of investigation include, as examples: (a): age-related memory disorders; (b) dissociation of memory systems; (c) assessment of memory and memory disorders; (d) depression and memory; (e) infantile amnesia; (f) context and memory; (g) memory enhancement; (h) scripts and schemas; (i) memory in natural contexts; (j)

parallel distributed models of memory; and (k) social psychophysiology of memory.

Interdisciplinary studies have provided strategies for investigating and understanding factors that effect or modulate memory, including factors such as drugs, neuromodulators, affective states, contexts, internal and external environments., and conscious vs. unconscious elements. Additional useful methods of research are based on different methods of approaching cognition, including: (1) cognition as information processing (i.e. computer modeling for the brain); (2) cognition as manipulation of mental symbols (i.e. use of memory mental images as events to be organized and manipulated); (3) cognition as problem solving (i.e. how the brain gathers and uses information in the pursuit of solutions to problems); (4) cognition as thinking (i.e. use of complex or higher order processes, including critical analysis, synthesis, and the like); and (5) cognition as knowing, remembering, perceiving, thinking, judging, problem solving, reasoning, learning imagining, conceptualizing, and using language (Houston, 1991, p. 348).

Cognitive science focuses on the mechanisms by which people acquire, process, and use knowledge. The importance of cognitive science lies in it being at the base of the educational practice. One of the major findings of cognitive research is that most students do not appear to learn at anywhere near their full potential during school years and are saddled with inability's in coping with tasks that require skills beyond rote execution of procedures (National Assessment of Education Progress, 1981). Cognitive studies have repeatedly shown that "there is also evidence that traditional schooling is not having the positive impact on the thinking ability of students that we would hope and

might expect it would have" (Nickerson, 1991, p. 4), and that "students show little improvement in performance from year to year" (McGilley, 1994, p. 3). One of the best reasons for learning how to think, how to memorize materials more efficiently, to be able to increase the usage of critical thinking, is stated quite elegantly by Costa (1991):

The school will become a home for the mind only when the total school is an intellectually stimulating environment for all the participants, when all the school's inhabitants realize that freeing human intellectual potential is the goal of education, when they strive to get better at it themselves, and when they use their energies to enhance the intelligent behaviors of others. (p. 19)

Through cognitive science studies, the brain, and particularly that part involving memory was conceived of in the language of computer scientists. Operating under such a computer analogy, memory is merely a location in which is placed a store of information to be used for calculations. The information is only a representation of some set of events, embodied in a pre-arranged code. The mental code provided by the nervous system is locked in the nerve fibers, which carry only one type of instruction. These nerve pathways were originally inherited through the organism's genetic code. In this computerized system, learning corresponds to change in the connection pattern of the pathways. The initial pathways become modified over time into the vast potentialities suitable for a future need of the individual. Acting under a defining set of circumstances, memory allows for choosing from that original multiplicity of possible actions those ones representing useful responses to the immediate environmental situation. All human skills involve selection of such formulated memories. Over time memories ensure appropriate behavioral response in the environment in which the individual is located. The problem

of memory enhancement is locating and accentuating the mechanisms that increase the probability of use for beneficial pathways while decreasing those mechanisms that are counter-productive for survival.

There appears to be some potential principles of memory that bring together various memory concerns, including acquisition, retention, and retrieval. These principles are (Cohen, 1985):

- (a) the better something is learned, the greater the likelihood it will be remembered;
- (b) the longer something has to be retained in memory, the less the likelihood that it will be remembered;
- (c) the likelihood of remembering something depends upon the nature of the memory test.

The first principle is supported by research on effects that include: (a) use of mnemonics (Nelson, 1977); (b) levels of processing (Seamon, 1980); (c) presentation rate (Cooper & Pantle, 1967); (d) frequency of item presentation (Nelson, 1977); (e) frequency of list presentation (Jacoby & Dallas, 1981); (f) primacy effect, involving remembering the first learned materials best (Rundus & Atkinson, 1970); and (g) the von Restorff effect, in which one item differing greatly from the others in a list is remembered better (Cooper & Pantle, 1967).

For the second principle, the recency effect seems to hold: the more recent the memory, the better the possible retrieval. This has been shown by many researchers (e.g.

Cohen, 1985; Lewandowsky & Murdock, 1989; Mewhort et al., 1994). However, two constraints are present. First, the method of testing appears to be critical: the less the explicit demands, the greater the recency effect (Brown et al., 1995). Second, for recall of memorized materials, there appears to be a limited span of the recency effect (Glanzer, 1972; Nairne & Neath, 1994).

A better way to state the third principle would appear to be: the closer the match between encoding and retrieval conditions, the better the memory performance. Such context effects appear to be reliable in predicting memory ability (Baddeley, 1976; Smith et al. 1978; Wingfield & Byrner, 1981).

The view of memory as a simple system of storage in the brain has given way to an interpretation of greater complexity. Complicating the view of memory as an integrated system are two areas of memory that need to be differentiated. They include fields involving processes and fields involving structures (Atkinson & Shiffrin, 1968). For example, remembering is dependent on three logically distinct but interactive processes: acquisition, retention, and retrieval. Acquisition deals with the acquiring of information. It is often, in some fashion, dependent on attention. A substantial part of this particular subfield of memory studies deals with what is acquired, why it is converted to code, and how the information is ultimately transformed into the representation that becomes the permanent memory trace. The variable affecting acquisition most is the amount of practice time. Retention is the storing away of the information acquired from experience until it is needed to be used. Retention problems investigated are ones of

storage of adequately coded information. The third process is known as recall or retrieval, dealing with the recognition or obtaining of stored information when it is needed to be remembered. Retrieval appears to be preeminently a strategic process, involving brain sector searching based on principles that have yet to be clearly elucidated. Retrieval is most often orderly, the recovered memories arising from a well organized storage system. Successful memory performance depends on a compatibility between the strategies of retrieval used and the strategies involved with the original encoding. To those three processes for entering, copying and maintaining information in memory investigators have also added encoding and elaboration. Encoding refers to any mental operations performed on information arriving in the sensory systems forming temporary or permanent memory traces. Elaboration refers to the establishing of cross-linkages between new information and previously stored information. This elaboration process is especially effective at promoting long-term storage of new information.

Many suggestions for memory storage, thought to be the most important factor in memory, have been presented. The biologist Ramon y Cajal suggested early in the current century that memory depends upon the formation of synapses. Pavlov believed memory (i.e. reflexes) was due to the spread of excitation and inhibition in the brain's cortex. However, neither of those ideas work in explaining long-term memory.

Permanent memories must be physically embodied in the brain, since they can endure for tens of years, withstanding shocks, anesthetics, freezing, heating, and other misfortunes.

As a consequence of that durability for many memory traces, memory is thought to be recorded on two or more time scales. Evidence for this dichotomy includes:

(a) limited storage capacity - short-term memory (STM) has a capacity of seven items (Miller, 1956), while long-term memory (LTM) is virtually limitless;

(b) two-component task studies indicating that there are two separable components, one relatively durable, the other involving rapid forgetting (Glanzer, 1972);

(c) differential coding studies, indicating immediate serial recall in STM to be based on speech-based phonological code, while long-term memory is apparently based on semantic coding (Baddeley, 1966);

(d) neuropsychological evidence suggesting STM and LTM are separate systems (Baddeley & Warrington, 1970).

In essence, the two forms of memory storage are separate. STM shows very rapid forgetting of unrehearsed information over short time intervals, an inability to hold more than a limited amount of information at any one time, the information stored often in a state of confusion due to other sensory inputs. LTM is retained over considerable periods of time, possesses effectively unlimited capacity, and seems prone to confusions of meaning only. Another differentiation of STM and LTM is based on the hypothesis that linkages between material stored in LTM are memories themselves. They may fade with time, but they may not be completely erased. Such linkages may be of substantial importance, since a bad or inappropriate link may continue to dominate the experiential memory of a learning event. Such a link may effect all subsequent connections to that

event. The result may be unpleasant associations which will cause the memory to be one that is not willingly, or with ease, recalled.

The topic of memory storage is tremendously complex. Although some investigators believe in STM (e.g. Atkinson & Shiffrin, 1968; Broadbent, 1984), other researchers believe that such temporary memory storage is actually only activated elements of LTM (e.g. Shiffrin & Schneider, 1977; Cowan, 1988). Some recent investigators have divided LTM into multiple separate types of storage, with separate procedural and declarative modules (e.g., Schacter, 1989) or separate procedural, semantic, and episodic modules (e.g., Tulving, 1985). Other workers don't divide LTM this way at all (e.g., Shiffrin & Schneider, 1977), or prefer to break LTM up based on differential coding methods (e.g., Humphreys, Bain, & Pike, 1989). To further complicate the problem's solution, there is an entire group of researchers who believe that all memory performance can be done on the basis of a single set of rules, invalidating the idea or need for STM and LTM entirely (e.g., Wickelgren, 1965; Crowder, 1989).

To summarize, student learning in a particular environment requires that:

- (a) attention factors, including processes such as focusing and maintenance, are essential;
- (b) short-term memory, involving a form of memory commonly known as working memory responsible for monitoring ongoing activities and accessing LTM, plays a significant role;

- (c) information representation in LTM involves storage, retrieval, and some form of organizational strategies (e.g. schemes, schemata, scripts) or depth-of-processing factors;
- (d) metacognitive processes play a substantial role in learning, the processes involving the goals of the learner, the type of general learning skills available, and the learner's understanding and interpretation of the learning situation.

The model most often used in memory investigations, with almost limitless alterations possible, is the simplified view presented in Figure 1. Each box represents a storehouse or repository of information. The arrows represent the possible flow of information from one location to another. Data first enters the system through one of the sensory organs of the individual. From the organ, it enters into the sensory storehouse, an area that seems to be able to hold as much information as is impacting on that particular sense organ. Information entering into this system decays away very quickly, in two seconds or less. Unless it is transferred quickly, it will be irretrievably lost. When data is transferred, it is transferred into the STM store in working memory. Two special constraints are acting on the working memory storage area: there is a limited capacity (about 7 objects), and the duration of a particular piece of information in the STM is limited to about 15 seconds. Desired information can be stored, by an unknown mechanism, in a separate section in working memory, called a rehearsal buffer. The information residing there can be retained indefinitely by the rehearsal process. For

information to be placed in that buffer requires deliberate action on the part of the learner in the form of focused attention. Finally, selective information can be transferred to the last storehouse, called LTM. This is an area of virtually unlimited capacity. This is the region people usually are referring to when they say something is memorized.

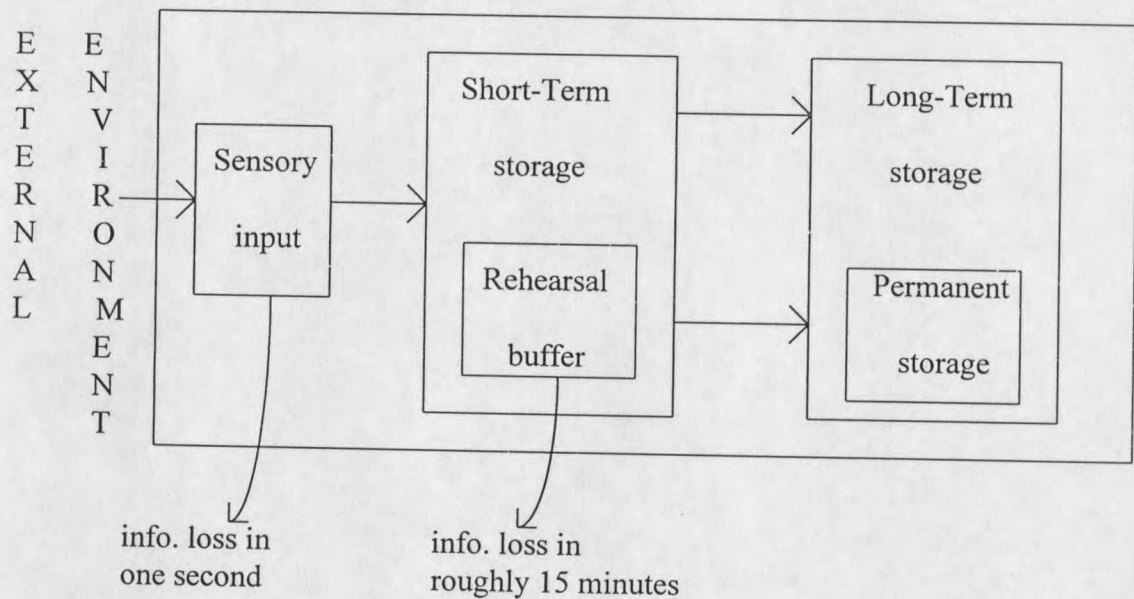


Figure 1. Schematic View of Memory Storage System and Processing Alternatives (Loftus & Loftus, 1976, p. 8)

Memory studies primarily are focused on factors involving attention problems, acquisition of information, encoding of materials brought in through the sensory modes, short-term memory, long-term memory storage, and retrieval/recall. Each subsystem has its own particular associated problems, with particular guidelines or rules that force differential responses from the associated subsystems. For a clearer understanding of

memory, and how it can be approached as a trainable part of the brain, each system needs to be investigated in more detail.

### Attention

One of the key factors in elucidating how materials are remembered by students is the attention level being applied to the learning process. The early practitioners of the art of memory realized that attention was a prerequisite of memory, so that by 400 BC the written rules of memory contained statements such as : "This is the first thing: if you pay attention, the judgment will better perceive the things going through it" (in Yates, 1966). It is clear that on a daily basis the brain receives massive amounts of data via the sensory apparatuses. However, it is equally clear that most of that substantial input is filtered out, discarded, or transferred into a region of the brain where it is confined from overwhelming the system with superfluous data.. In place of a gigantic accumulation of raw informational elements, only certain specific materials are allowed into the brain storage system for further retrieval or analysis. These retained materials are those that have some aspects deemed important enough by the organism to focus attention on.

Unfortunately, attention is one of those terms defying adequate boundaries. At least seven different processes were described as attention (Phye & Andre, 1986), including: mental concentration, vigilance, selective attention, search, activation, set, and analysis by synthesis. Among cognitive researchers studying the acquisition, representation, and use of knowledge, attention is the system "involving our ability to

select among competing data so as to bias our memory, responses, or current thought towards some contention rather than others" (Poser & Friedrich, 1986). Attention is viewed as a limited resource by which particular cognitive processes are mobilized and maintained. Researchers have alternatively described it as energy, capacity, effort, resources, and fuel (Britton, Glynn, Meyer, & Penland, 1982; Kahneman, 1973), but the dilemma is stated best by James:

Every one knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others. (James, 1890, pp. 403-4)

Defining attention as applicable to memory studies is not quite that easy, in that there are other elements that need to be included. Shiffrin's (1988) definition is more inclusive:

Attention has been used to refer to all those aspects of human cognition that the subject can control ... and to all aspects of cognition having to do with limited resources or capacity, and methods of dealing with such constraints. (p. 739)

The relationship between attention and memory can be stated in terms of how much can be attended to at one time (James, 1890):

The number of things we may attend to is altogether indefinite, depending on the power of the individual intellect, on the form of the apprehension, and on what the things are. When apprehended conceptually as a connected system, their number may be very large. But however numerous the things, they can only be known in a single pulse of consciousness for which they form one complex 'object' ... so that properly speaking there is before the mind at no time a plurality of ideas... (p. 405).

However, it should be noted that there is no general conclusion on the role of attention in learning. In fact, contrary to James's statement, workers with animal learning behavior (Rosenzweig, 1986) have concluded that learning can occur without awareness or attention. Researchers of human verbal learning find attention absolutely essential for learning, while neuroscientists find attention irrelevant to learning.

What can be said with confidence is that attention is a significant factor in a total cognitive system. That system is conveniently viewed as a three stage model involving: (1) a perceptual stage; (2) a comprehension stage; and (3) an elaboration stage. The perceptual stage uses the sensory receptors to recognize and gather information from the environment. The comprehension stage applies meaning to the input by use of previously stored information, rules, and experiences. The elaborative stage uses the stored data for problem solving, inferring, and other activities such as critical thinking. This model, however, is in complete contrast to the processing of information without attention, referred to as automatic processing (Kahneman, 1973). As a cognitive state factor, attention is related to arousal. When in a state of arousal, an individual is alert, aware of the environment, ready and expecting to receive particular types of information, and prepared to act on the incoming information. This alertness (Mackworth, 1970), correlated with physiological evidence, such as changes in heart rate, breathing, brain wave patterns, requires less effort on the part of the individual to avoid distractions. But such an arousal state varies between individuals (Hamilton, Hockey, & Rejman, 1977). The Yerkes-Dodson Law (Yerkes & Dodson, 1908) states that for any activity, there is an

optimal level of arousal for peak performances. Below that level of arousal, due to elements such as boredom or fatigue, mental performance drops off. Surprisingly, above the optimum level, due to elements such as stress or pain, performance again slumps (Kahneman, 1973).

Although attention has not been satisfactorily defined, the basic functions can be reasonably delineated. Basically attention is characterized as stated by James (1890) early in the formative studies : "My experience is what I agree to attend to." This makes the immediate factors of attention evident. They contribute to make us: (a) perceive; (b) conceive; (c) distinguish; (d) remember; and (e) shorten reaction-time (Norman, 1976). Depending on the environmental circumstances, the relative importance of the factors vary. A factor of utmost importance under one set of circumstances would be ranked substantially lower under a varied set of conditions.

In all instances, it seems that attention acts as a control mechanism which allows any living organism to focus exclusively over an extended time period on a specific situation or problem. This sustaining of focused perspective is an absolute necessity in all environments for organisms at even the lowest levels of organic development. No matter how evolved the organism, it is bombarded continually with a tremendous quantity of stimuli, at least some of which may be essential for the imminent survival of the organism. All organisms require the ability to separate out those stimuli needed for continued survival from those stimuli of little consequence.

In higher level organisms, which are more responsive to environmental signals by virtue of their highly developed brains and nervous systems, the attention mechanism must be able to ensure that a definite, finite amount of information is processed or even allowed admittance to the operative analytical centers of the organism. Because the input needs to be analyzed immediately to determine possible advantageous or lethal effects on the individual, the attention mechanism must also be able to access from the prior behavioral memory stores only that material needed to allow the organism to successfully evaluate and use the current input. In effect, whatever the mechanism for attention or concentration is, it must be a narrow conduit allowing for the channeling of limited information from two directions: (1) as input from the external environment, and (2) as a supplier of past experiences and evaluative analysis criteria from the centralized nervous system (i.e. brain, nervous tissue, individual neuron).

For advanced organisms operating in the real world, it is essential to be able to shift the attention mechanism from one situation/input to another in a very small amount of time. This would produce great survival value in any environment where sudden changes in conditions (i.e. arrival of a predator) would necessitate an instantaneous change in focus. Such a shift would be closely related to the speed of sensory detection for changing stimuli. It would be expected that such shifting would be most visible in organisms with higher developed nervous systems. This shifting of attention as necessary when the operative context changes has been referred to as priming (Anderson, 1976).

One of the difficulties in dealing with attention are the variety of different definitions for the term. Fortunately, the level of differences in meaning may only be an illusion, in that all the meanings may actually be closely tied together during the brain's activities. Some researchers have found that a useful form for attention, as mentioned above, signifies arousal, the state of alertness, excitedness, of being aware of one's surrounding environment in an enhanced manner (Mackworth, 1970). Such arousal, however, does not necessarily correspond to mental alertness or performance ability in that it may be merely a physiological function. Another form of attention would be selective attention, allowing the individual to distinguish a stimulus from another, to be able to remove any and all potential distracters. For most investigators, this form of attention represents the control mechanism that will ultimately determine what stimulus gets coded and stored in memory. Such selective attention can seem absolute, allowing a learner to become so deeply immersed in a subject that no normal outside distractions can intrude. But there are also occasions when the selective barrier is breached, at which time the ability to focus attention becomes so reduced that any learning is impossible. Schizophrenic patients quite often have such a problem, for example as reported by McGhie and Chapman (1961):

My concentration is very poor. I jump from one thing to another. If I am talking to someone, they only need to cross their legs or scratch their heads and I am distracted and forget what I was saying. I think I would concentrate better with my eyes shut... (p. 104)

The most influential theory of arousal and memory was proposed by Walker (in Holt, 1964), who argued that any psychological event would establish a preservative trace lasting for some length of time, during which long-term memory would be established. Walker assumed that high arousal as related to motivation had the effect of producing a longer lasting active trace. Such motivational arousal leads to greater long-term memory, but also to possibly a larger initial inhibition of retrieval. That inhibition would act to protect the trace and prevent disruption. Although many investigators have obtained results in harmony with Walker, others, especially those dealing with free recall experiments, have produced results inconsistent with the predictions (see Holt, 1964).

To counter the arguments against Walker's action-decrement theory, Berlyne (1965) proposed that an intermediate level of arousal was optimal for performance, and that changes from either high arousal to intermediate or low arousal to intermediate levels would be reinforcing for both STM and LTM. However, many experiments have shown a curvilinear relationship exists between arousal and short-term retention, opposite to what was predicted (Houston, 1991). Arousal is directly related to storage strength, with storage strength at all levels of arousal increasing for approximately one minute, followed by a slow decrease. Eysenck (1977) argues that high arousal has the effect of biasing the subject's search processes towards readily accessible information more than is the case with lower levels of arousal. As task difficulty increases, the accessibility of required information decrease. This is intimately associated with the learner's own expectations towards the task or material to be learned.

In place of a single mechanism, there may be at least a cluster of three working parts involving the attention process. The first mechanism focuses on external input, channeling in only that information relevant to the current situation. The second mechanism controls the internal transference from memory of prior experiences, memories, or data that are crucial to interpreting the information passed on by the first mechanism. It also acts to filter out most additional extraneous materials. The third attentional mechanism allows for interrupting the current focus of attention and shifting it to another context with higher priority. All three mechanisms of control focus on selectivity of data in terms of recognition and usage.

Attention appears to often involve some other subsystems. Evidence for this comes from studies of the "cocktail party effect". In this situation, a person tends to miss what is being said because more distant conversations or activities have more attraction than the immediate conversation. For example, although deeply engaged in a conversation about an emotional topic, the listener may be distracted by hearing his own name being used in a conversation within hearing of his own dialogue. In laboratory research, the experimental method used to investigate this ability to shift attention from one region to another based on interest is called dichotic listening. In the experiments, different messages are sent over each earphone encasing the subject's ears. The results are simply stated: little is remembered from unattended messages (Treisman, 1964), but significant elements, such as the subject's name, can easily momentarily divert the attentional focus.

This effect, and the associated experiments, demonstrates a number of basic properties of attention:

- (a) if attention is not paid, no information is acquired;
- (b) there are finite limits on an individual's ability to process information; this limits the range of activities going on around an individual for inclusion into memory storage;
- (c) there are individual differences in what one person attends to as compared to another; when no interest is evident, rarely is a person attentive enough to retain more than a trace of the material being discussed (Halpern, 1989).

However, there is a paradox here. At a real party, a person might appear totally unaware of what is going around about conversation-wise, until their name is spoken. At that juncture, most people find themselves switching their attention to the other conversation, as if they had been paying some attention in the first place! Clearly, the human capacity for attention is definitely limited, forcing individuals to focus on one communicative interaction in place of another. But, at the same time, since people can detect relevant bits of information in other conversational channels, it must be that the brain is also, in some fashion, paying more than just a passing amount of attention to the auxiliary conversational regions (Cherry, 1953).

These last two effects have led to two groups of models for selective attention. The first group concept revolves around the factor of time-sharing: these models all postulate a limited system of memory capable of accommodating only one meaningful

input at a time. For situations with more than one input, the brain uses the principle of time-sharing. The mode is characterized by the attention rapidly shifting back and forth between channels conveying the discrete information stimuli. The channel given priority is established by the relative amount of time devoted to the one channel versus the others. Such models include Broadbent's (1971) "filter theory", and the "single channel" models of Cherry & Taylor (1954) and Welford (1977).

The second group of models are called "capacity models". All assume that simultaneous inputs can be processed in parallel to one degree or another. Attention strategies are represented as differential allocation of the limited processing resources to the inputs. The basic models are given in Johnston & Heinz (1978), Kahneman (1973), and Norman & Bobrow (1975).

Attention in the time-sharing models is most widely known through the idea of a filter. Broadbent attempted to piece together a model of human memory capability that would account for a wide variety of data (Broadbent, 1958). He proposed the brain contains a selective filter that can be tuned to accept the desired message and reject all others. The filter blocks undesired inputs, reducing the processing load and time for the perceptual system. Different environmental features and elements of the inputs are identified as acting as a basis for the selection. Such factors include intensity, pitch, spatial localization of sounds, and time changes since the last information from that class of events occurred. Broadbent assumed the shift of the selective process from one class

of events to another takes a negligible, hardly noticeable time. His central concept, agreed with by many researchers following his lead, included three elements:

(a) discrimination and channel separation of the incoming data (i.e. isolating and separating the elements from conflicting sources); (b) action of a perceptual filter; and (c) passage of filtered, meaningful information through to the long-term memory storage area. One additional idea, a major modification of Broadbent's original version of all-or-nothing discharge in the time-sharing basis, was formulated by Treisman (1969). He postulated a filter that attenuated, rather than completely blocked, all but the relevant channel(s). However, lest it be seen that all researchers agree with the "filter model", it should be noted that some researchers, such as Deutsch & Deutsch (1963) believe that all information is completely analyzed automatically by the brain. Attention is used only to establish which part of this analyzed information will enter into the learner's LTM.

Capacity models of attention stand in contrast to the time-sharing models. There are numerous versions, but they share two common major elements: (a) simultaneous inputs are processed in parallel on a "space-sharing" basis (Treisman, 1960); and (b) there is a single pool of processing resources, known as capacity, that must be allocated among all incoming stimuli. When the number of stimuli requiring analysis exceeds the limits of this capacity, task priorities are set by the brain. When complex processing of a primary channel monopolizes most of the capacity, there may be enough left over for secondary channels to allow for detection of other inputs, such as hearing one's name, a warning cry, or some other recognized signal. For example, in Sternberg's model (1975), the

system works as: (a) the primary stimulus is first encoded; (b) a decision is reached concerning the amount of attentional capacity needed and the response type that is appropriate for the stimulus as it has been encoded; and (c) a motor response is planned and executed while the brain continues to analyze new incoming data. The most complete form of the capacity model was presented by Kahneman (1973), who emphasized the potential flexibility of resource allocation.

Attention is considered in both these groupings of models as a processing capacity or required degree of effort. As Kahneman wrote (1973):

Different mental activities impose different demands on the limited capacity. An easy task demands little effort, and a difficult task demands much. When the supply of attention does not meet the demands, performance falters, or fails entirely. (p. 9)

In effect, the individual controls the attention factor. The learner chooses the allocation of available resources, guided by the brain's allocation policy. That mental policy is influenced by the capacity demands required by the activities, the individual's momentary intentions, and any predisposition toward the inputted data.

There are also newer models of attention available. Researchers refer to these as modular models. One example is the interactive activation model of McClelland and Rumelhart (1985). In their conceptual model, different levels of analytic units, such as features, words, or phonemes, can be interpreted as separate but interactive models. More common are the system-wide computer models of attention (Anderson, 1983, Schneider & Detweiler, 1987, Newell, 1990). These models have returned to treating the brain as a

computer analogue, with different subsystems controlling components of attention as the subsystems are called up by different mental activities.

The attention system may actually involve two groups, the time-sharing model and the capacity model, simultaneously. Quite often there appears to be two types of attention phenomena operating in the instructional environment. The first type is known as primary attention. This is depicted as the act of selectively focusing receptors on a stimulus and filtering the information through the sensory system (Norman, 1968). The input is governed by what the learner feels is important to learn in the stimuli being considered. Primary attention is basic in nature.

Of more interest to researchers is the second type, called processing attention. This attention type directs encoding activities, setting the limits for what will be learned and remembered. Some material will be accentuated, while others are lost. Which case occurs for individual pieces of information depends on the processing provided (Anderson & Faust, 1967). Processing attention can be manipulated and strengthened by adding stimulus elements to the material, providing cues concerning what is believed to be critical material (Gernsbacher et al., 1992). Such a clue would be, for example, telling students which areas of content they should primarily focus on (Phye & Andre, 1986). However, without such clues, learners still focus attention towards those parts of a learning task that they judge to be most important. This attentional focusing is probably controlled by two factors: (1) the structure and nature of the learning task; and (2) the materials which form part of the prior knowledge and expectations of the individual. Due

to those variables, Kahneman (1973) suggested that people can only bring a relatively fixed volume of processing attention to any instructional task. The material learned are those segments which the learner perceives as having the greatest potential payoff (Anderson, 1983).

Since attention is so important a factor in learning and memory, it has been frequently commented that today's normal classroom environment for students is dull, repetitive, and passive, just the opposite of what is necessary for optimum attention and development (Silberman, 1970). Many suggestions have been put forth for improving levels of alertness (Good and Brophy, 1984), including: (a) preventing the classroom from becoming too predictable; (b) avoiding repetitiveness; (c) teachers being non-monotonous; (d) varying the type of presentation; (e) limiting the time involvement; and (f) focusing the attention at the onset of instruction. An additional complicating factor to optimizing levels of attention is the physical environment. In the region where the teacher spends most of his time, known as the action zone, the attention level is much higher than anywhere else in the room (Professor E. Peressini, personal communication). To generate more interest in non-attentive students, it may be necessary to move them closer to the action zone. For students studying alone, attention can be focused by: (a) making themselves totally involved in the learning process; (b) keeping materials moving; and (c) avoiding endless review. Other strategies that help students become selectively attentive include underlining or copying (Houston, 1991) or enhancing the prominence of the material (Franklin & Tversky, 1990). However, other studies found no

special value for the commonly used technique of underlining (Idstein & Jenkins, 1972). Reading may involve learning, to be certain, but it has long been known (Bugelski, 1979) that reciting is far more rewarding than reading. Reciting amounts to attempted retrieval, one of the keys of developing a strong memory. This is what Ebbinghaus (1885) attempted with his procedure of measuring memory by using nonsense syllable lists.

Lastly, the importance of imagery in attention needs to be noted. Researchers have long suggested (Bugelski, 1979; Atkinson & Raugh, 1975) that students attempt to picture everything read. If the student can schematize, draw, or create a physical model, either mentally or on paper, the conditions are optimum for focused attention of the highest quality.

The derivable conclusion is that in improving memory skills, attention processes are of priority importance. For example, two of the most difficult things for people to remember are names (and associated faces) and numbers. It is likely that the names and numbers were never paid adequate attention in the first place, so that they were lost from STM almost immediately (Lorayne & Lucas, 1975). The hypothesis is generalizable: when information is not acquired or recognized in an attentive fashion, there will never be any remembering taking place. One might think this obvious, but it does not appear to get taught in schools. John Holt (1964) in his work How Children Fail believes emphatically that children who would normally do well in school often fail because they do not pay attention to what is occurring. Attention skills need to be enhanced for

significant memory skills to be formed. Better encoding appears to take place for attended stimuli, especially when multiple conflicting stimuli are present (Treisman & Gelade, 1980). Information that would normally be lost can be retained longer with attention and rehearsal (e.g., Vallar & Baddeley, 1982; Cowan et al., 1990). And finally, more deliberate recall is possible when similar attention levels are present at the time of encoding and retrieval (Jacoby et al., 1993).

### Motivation

One factor that has come into prominence with attention studies is the role of motivation. The obvious fact regarding humans in terms of attention and motivational ability is there exists tremendous individual differences. There seems to be almost an unlimited number of factors that influence motivation. Some factors cause simple arousal, such as heat, noise, incentive, alcohol, stimulant drugs, sleeplessness, sensory deprivation, anxiety, and introversion. Others are more deep seated factors, such as intelligence, reasoning ability, emotional levels, or cognitive elements. Broadbent (1971) has shown that to deal with motivation the factors need to be separated into physiological and psychological concepts. For example, the distinction between hope for success and fear of failure was made explicit in the theory of motivation developed by Atkinson (Entwhistle, 1981). Motivation includes two elements: (a) intrinsic motivation or the motivation to achieve success; and (b) extrinsic motivation or the reasons produced externally for going after a goal. Atkinson believed that a person's actual achievement behavior depended on the level of need for achievement, and on how the

task presented was interpreted. He described this theory as dependent on the strength of the need to achieve success, assuming that interest and performance on some task depended on the motive to achieve success, the strength of expectancy for success and the relative attractiveness of success for the particular activity. Failure would be due to not simply a lack of motivation, but also an expectancy for it to occur.

Where does motivation come into memory research work? As Whitehead stated, "There can be no mental development without interest. Interest is the sine qua non for attention and apprehension. You may endeavor to excite interest by means of birch rods, or you may coax it by the incitement of pleasurable activity. But without interest there will be no progress" (Whitehead, 1967). Unfortunately, much in modern education and society mitigates against this general motivation factor. Humans seem to be born with an innate curiosity and sense of wonder. During the early period of socialization and schooling, there appears to be induced in many students an attitude of intellectual passivity or disengagement, and negative preconceptions about academic disciplines (Meyers, 1986). Part of the problem centers on the need and pressure for children in the classroom to remain silent and follow instructions rather than ask questions. Another aspect of the problem stems from the fact that students are rarely given enough time to become fully involved in a subject. Instead, they are shuttled back and forth between different activities every hour on the hour. The most critical component here is the traditional fifty-minute long class format. Nothing better could be educationally designed to impede interest and discourage critical inquiry.

The second barrier to motivation is the negative attitudes often carried by students towards academic studies. Some attitudes are due to poor teachers: some are due to individual likes and dislikes. Some subjects are perceived as boring or trivial, while others are viewed as extremely difficult or even impossible to do without genius levels of intelligence. These negative motivational beliefs carry over subsequently into poor study skills, memorization ability, and general cognitive activities.

To overcome the problems of motivation, there is a need to encourage inquisitiveness and reflectiveness as mental habits. Such inquisitiveness would begin best with things not understood. "Let it be known early on, that there are deep mysteries and profound paradoxes ... Describe as clearly as possible ... that there are some things going on in the universe that lie still beyond our comprehension, and make it plain how little is known" (Thomas, 1982). Others such as Lipman (1976, p. 56) suggest using materials that contain "intellectual shock and surprise" to capture the student's interest and thereby increase motivation. Both of those ideas fits with Piaget's concept of disequilibrium and its role in creating motivation to learn new mental structures. Piaget was, however, applying it to children: it seems just as appropriate for adult learners. Meyers (1986) elaborated with, "Students must first be made both curious and uneasy by presentation of an interesting problem for which no certain answer exists. Then, once interest is captured, they can be guided to learn new modes of thinking and to develop confidence in their ability to analyze and solve problems" (p. 15). Motivation is essential to memory. Many theorists feel the key to learning or memory is to relate new learning

to previous knowledge. In any successful teaching of students, the teacher should lead them from concrete skill development to more abstract modes of thinking, always beginning by building on past experiences and existing mental structures. Donald Norman states it succinctly: "Examination of the way in which our students learn indicates that they build upon previous structures. Essentially, they tend to learn by analogy ... In order to understand the topic, you have to be able to relate it to other things you know" (1980, p. 44). New ideas and concepts are connected by analogies to prior knowledge. More difficult concepts may make use of metaphors and figurative language. "Metaphor suggests something more than analogy, for in metaphorical comparison, a new quality or connection is disclosed in the thing compared that was not previously apparent" (Jones, 1983, p. 51). A good example would be the feature astronomers call a black hole, a great metaphor for a bottomless well in space from which light can't escape.

### Acquisition

Once attention is focused, a subpart of the memory process is that of obtaining information to be encoded and stored. Acquisition refers to those processes that occur during the establishment of a memory pattern or in the formation of an association (Houston, 1991). Although it is believed that information is often put into memory by the time-honored processes of practice and reinforcement, there are also other mitigating factors. Transference, as one of these factors, refers to the effect that a learned task or piece of information has on future attempts to learn additional tasks or store additional

similar information. Positive transfer involves one learning experience facilitating another: for example, knowing French allows a student to learn Spanish in a much shorter time and with greater ease due to similarities between the languages. Negative transfer occurs when prior learning hinders future acquisitions: for example, failing in a mathematics class may establish a mental barrier, hindering success in a future mathematically-oriented physics class.

In the process of acquisition, one of the oldest assumptions is that temporal continuity is necessary for adequate learning to occur. Psychologists have assumed that the response must occur in the presence of, or very soon after, the stimulus is supplied for an association to be established (Houston, 1991, p. 126). However, even though it seems that non-contiguous learning would be unlikely, there are verifiable instances when it occurs. Tulving (1966), using subjective organization experiments, in which randomly arranged lists of unrelated words are presented one word at a time to the subjects, found that when the list was again presented, but in a different order, the subjects began to recall certain items next to each other, in a sequential form. The number of such ties increased as the experiment progressed. This suggests a lack of temporal continuity as a necessary requirement for association formation. In place of a time contact, there is only the need for subjects to organize materials creatively inside their own brains. Similarly, in additional experiments on short-term memory situations, Glenberg & Bradley (1979) found no stimulus-response contiguity necessary for learning to occur.

The original time-related acquisition belief is the idea that a stimulus is required for any learning or memory to occur. Logan (1970, p. 8) defines a stimulus as "any adequate change in energy falling upon an appropriate sensory receptor". Sounds, sights, tastes, or any other form of sensory input would be an appropriate stimulus: thinking could also be considered a stimulus under study conditions. However, it has been repeatedly shown that when not enough attention is paid to a particular stimulus, the input can be ignored: attention is absolutely essential (Bourne, Dominowski, & Loftus, 1979). Another problem is with the idea of needing a long-duration stimulus. Quite often, a single stimulus burst, brief and perhaps of non-noticeable duration, is sufficient to build a memory trace. In other words, the lengthy continuation of a stimulus is not a requirement to form memories. As many students know from failures on classroom examination, continual input from an outside source such as reading materials is no guarantee that a memory trace will be formed. Nor, if an association is formed, is there any assurance it will be of lasting duration. Once that external stimulus has been perceived by some sensory apparatus, the message carried will be internalized: what exactly determines the subsequent development or loss of the stimulus-derived association is unknown.

This process of acquisition, or obtaining information for long term retention, is thought by many researchers to be a highly involved activity (Bartlett, 1932; Nilsson & Archer, 1985). Remembering is viewed as an interaction between external events and mental activities. But remembering is also related to a person's history, previous experiences and individual development through growth and maturation (Tulving, 1985,

p. 70). This allows for the formation of two forms of association traces distinguishable by their input: (a) memory of experienced events, in which the individual participated; and (b) memory of reported events or ones dealt with through second-hand experience (Neisser & Winograd, 1988). Each type may be recorded differently, since there is more involvement in the personally experienced events. Numerous studies have shown that people group their own memories into conceptually distinct and coherent categories of meaningfully related events particular to themselves, not necessarily like those anyone else would use (Houston, 1991). Categorizing and grouping is based on autobiographical constraints. This allows for placement of the material into a framework which would be cohesive and allow an individual to develop a sense of self (Neisser, 1967). It is clear that memory for events constituting a traumatic episode are enhanced compared with those remembered for less significant events.

For information acquisition, it is important to realize that memory is malleable: acquisition often depends on how material is encoded or interpreted, not necessarily on the events themselves or the information acquired. Johnson & Raye (1981) showed that people often cannot distinguish between their own thoughts and their perceptions. Such fallibility is often noted in eyewitness reports when done in scientific experiments. To make memories stronger, materials are studied for meaning, requiring elaboration on the part of the individual. Relating new information to material already in LTM is a well developed form of such elaboration, which aides in increasing comprehension. The

factors of acquisition and comprehension are intimately related: anything that improves comprehension also improves memory (Bransford & Johnson, 1972).

### Encoding

That factor of memory involving the transformation of information into a form useable by the brain is called encoding. The term refers to initial learning or coding of information. It is intimately related to ultimate storage and use of memorized information. The basic theory entails encoding processes leaving a residue in the nervous system, known as memory traces, persisting over time. Like the rest of memory system processes, encoding seems to involve more than one process. These operational processes are included under encoding variability theories, due principally to Bower (1972) and Martin (1972). Both researchers have shown that there are a number of different ways in which to-be-remembered information can be encoded. That encoding variability has the potential of giving rise to many effective retrieval routes. Glenberg (1979) proposed that one possibility, called the automatic encoding variability processes, is responsible for the spacing effect (i.e. time intervals necessary between repetitions) in free recall. His rationale was that free recall should depend to a great degree on contextual cues, which are assumed to be encoded automatically. This model stands in sharp contrast to those referred to as deficient-processing theories. Those models postulate that massed repetitions receive less processing than their spaced counterparts

and that recall is a function of the amount or quality of processing the information receives (Hintzman 1974).

Acquisition also relates to encoding. Encoding can be a detailed process, as evidenced in the operations that are necessary for the recognition of faces as a memory skill (Ellis, 1992). With faces, the encoding process comprises four stages: (1) a structural encoding of the face's appearance in such a manner that information highlighted makes the face unique, while at the same time establishing clues to the face's owner; (2) activation of a visual representation of the face so that it can be perceived as familiar or not, depending on what is already stored in memory; (3) access to semantic information associated with the person and stored in LTM (otherwise the face would stay that of a total stranger); and (4) retrieval of the person's name associated with the face. Support for this model is virtually overwhelming in terms of experimental evidence (Brennen et al. 1990; Young et al. 1986).

A particularly interesting relationship between encoding and retrieval factors was found by Hunt & Einstein (1981). Using a sorting rating and a pleasantness rating, they found the effect of a study variable depended on the type of list (i.e. related or unrelated words) as well as on the type of test (i.e. either free recall or recognition recall). Sorting worked best for free recall when dealing with the unrelated word list. Pleasantness of words produced best results for recognition recall for the related word list. For unrelated lists, pleasantness rating and sorting produced similar recognition scores. Results of these experiments explain several phenomena mentioned in the literature: (a) relational

processing can provide an account for the organizational bases of recall (Anderson, 1972); (b) item specific processing can be understood as a well remembered distinctive event by learners retrieving items from a category. The same latter process may be what occurs for flashbulb memories (Brown & Kulik, 1977).

It is well understood from cognitive science that our brains are continuously remembering material, without any effort or conscious activity on the owner's part. It is also understood that individuals do not remember everything sensed or thought about all the time. There appears to be limits set by the brain itself on what is encoded to become a permanent memory unit. As mentioned above, remembering seems to be most difficult when it becomes a deliberate activity (Holt, 1964, p. 34), with the focus of attention undertaken in opposition to what the brain wants to focus on. Remembering is difficult when it is contrived or forced: material the brain has no interest in is difficult to convert to LTM.

Remembering deals with differences between unconscious and conscious processing that occurs continually. There are several differences between the two forms of processing (Mandler, 1985, p. 93):

- (a) unconscious processing: automatic, having the characteristics of being fast, immediate, uncontrolled, having no capacity demand, allowing direct access, involuntary, being context free;

(b) conscious processing: non-automatic, having the characteristics of being slow, mediated, controlled, capacity demanding, allowing indirect access, voluntary, context dependent.

The increased ability to recall information may be due to the distinctiveness of the encoding occurring after deep or more elaborate processing. For simpler encodes, not requiring much mental manipulations, this means that successive inputs probably are very similar to each other. At higher encoding levels, requiring more mental ability or in-depth critical thinking, there would be greater differentiation and greater elaboration, making the material more amenable to later retrieval. The process would be like placing a flag on the information, making it markedly different from other items in the same categories. In general, uniqueness of the encoding improves recall for most materials. Performance in retrieval/recall tests increases in relation to how well the encoding operation differentiated the datum from other data at the same level of encoding (Stein, 1978). An important factor in such retrieval is that encoding performed during the retrieval method (i.e. testing method of the experiment) must be compatible with the initial encoding operation. The best encoding is the one that is most compatible with the particular retrieval task used to test recall (Bransford, Franks, Morris & Stein, 1979).

Encoding works at optimum efficiency when it is associative. Each datum or concept would have a unique internal representative. For maximum ease of recall, this representation would be associated with as many other representations as possible in the brain's LTM storage area. This can be contrasted with the idea of non-associative

memory. For such memories, each concept is stored in an ordered set of locations and are not related by association with any other representation. The theory of multi-traces (Gregg, 1972), one of the more popular memory theories, assumes that human memory is largely associative. Four types of associations within or between representations are possible: (1) inter-event associations, allowing for direct forward and backward associations between the representatives of successively presented events; (2) intra-event associations, providing connections between the representatives of the simultaneously presented components of an event; (3) concept associations, defined as associations between the representatives of the simultaneously presented components of an event and a concept representative for the event; and (4) structured associations, which are associations between the representative of an event and cognitive structure representatives such as the familiarity representative, serial position concepts, subgroups labels, and rules. Associative memory permits both recall and recognition recall to occur easily. In the dynamics of multi-trace theory, the most important factors are the acquisition of sensory input, consolidation of retrievable memory trace strength, possible subsequent decay, and retrieval/recall as required in the future.

### Short-Term Memory

Short-term memory (STM) is transient and easily interrupted. This is the conscious contents of the mind, involving the most recognizable parts. In cognitive theory, it is the storage area for the end result of a perceptual event ( Bjork, 1975). It is

also referred to as working memory, comprising the entire framework that selects the appropriate input, maintains such an input in an active state, and allows determinations for transference of information to LTM (Baddeley, 1992). In a more specific form, it is the part of the brain memory system that gathers and manipulates information as needed for the performance of an entire collection of more complex cognitive tasks.

Evidence for such a temporary memory storage area came from research on word-length effects (i.e. the shorter words are, the easier they are to recall when compared to longer words) (Baddeley, Thomson, & Buchanan, 1975). It was discovered that STM possessed a time limit for a temporary phonetic memory trace. The pattern decayed in about two seconds if not refreshed through a covert rehearsal process (Baddeley, 1986). However, evidence indicates there are at least two separate forms of STM. The case for STMs representing information in speech-like form and in visual forms is especially strong (Frick, 1984; Baddeley, 1986). There may possibly be even many more. In particular, there is evidence for a haptic STM (Bowers, Mollenhauer, & Luxford, 1990) and for some other system independent of the sensory modality in which the information originated (Farah, Hammond, Levine, & Calvanio, 1988). Further studies suggest individuals can even acquire a special-purpose "kinesthetic STM" (Reisberg, Rappaport, & O'Shaughnessy, 1984).

The basic characteristics of each of the STMs are, however, roughly the same. Each system of STM is labile, and decays over a period ranging from several seconds to hours (Cowan, 1993). If the information is not recalled during that period, or transferred

to LTM, it is irretrievably lost. The code trace representation of the STM appears different under different task demands: possible varieties include visual coding (Cooper & Shepard, 1973), semantics coding (Shulman, 1972), and an inter-twinning of sound-based codes and visual codes (Healy, 1982). The coding format may be influenced to some extent by an individual's dominant mode of communication (Shand, 1982). Coding is transient, as mentioned, with numerous factors affecting the trace representation in either a positive or negative fashion. For example, since certain drugs, including strychnine and amphetamines, seem to enhance STM or facilitate trace transfer to LTM, the hypothesis is that whatever form STM is held within the brain must involve transient changes in the electrical properties of the brain as a system. Studies indicate that the hippocampal region of the brain is closely involved in the mechanism of STM. STM seems to be of much use in higher cognitive skills, such as comprehension, critical thinking, problem solving, or even reasoning (Cantor, Engle, & Hamilton, 1991; Cowan, 1988; Just & Carpenter, 1992).

STM as a storage center is dominated by chunking (Miller, 1956). A perceptual component of working memory permits the brain to rearrange incoming information into meaningful or familiar patterns called chunks. More manageable units are stored in what is recognized as a myriad of separable subsystems, each one designed to handle the creation and control of modality-specific or task-specific STM (Burgess & Hitch, 1992; Schneider & Detweiler, 1987). The most commonly accepted mode of operation for this system is that proposed by Baddeley (1992), involving a tripartite system. This trio of

subsystems consists of a main controller that handles and controls on-line attention processing, and two subsidiary slave systems, known as the articulatory loop and the visuospatial sketch pad. The loop is a short-term storage area for speech-based material. One of its primary functions seems to be controlling subvocal articulation or rehearsal. Continued rehearsal in this subsystem improves memory and storage time. A second function is to transfer visually presented material into phonological form (Schweickert, 1993). The visuospatial sketch pad is focused on an important subjective component of mind: that of visual images. The sketch pad in the short-term storage component of working memory appears to facilitate the handling of visual and spatial information for processing into LTM (Nairne, 1988, p. 110). Experiments have been done (Baddeley, 1992; Baddeley & Lieberman, 1980) that suggest that the visual and spatial components are in reality dissociated, being controlled by separate systems in the brain.

Before it is thought that the loop and the visuospatial sketch-pad are definitely identified parts of working memory, it should be noted that there are alternative explanations possible for the working memory system. Articulatory suppression has been found to eliminate the word length and phonological similarity effects (i.e. similar words are remembered with more difficulty than discernibly different words) (Nairne, 1990). Cowan et al. (1992) has shown that the word length effect may actually occur in the output stage rather than during the input stage. Similar experiments with probed recall resulted in the same conclusion regarding the output stage (Avons, Wright, & Pammer, 1994). Time limits also seem to have a critical determinant. That particular determinant

is the speed or efficiency with which test subjects can re-activate items during the pauses occurring during the recall output period (Cowan, 1993). Taken together, the collection of three results suggest memory span and word length effects are complex phenomena influenced by multiple factors (Gathercole & Adams, 1993; Lipointe & Engle, 1990; Avon et al., 1994). Some form of mutual interaction between resource-limited reactivating processes and processes of forgetting is necessary. The results of more recent studies (Caplan et al., 1992; Baddeley & Andrade, 1994) suggest that a complete understanding of short-term memory, particularly involving factors such as time limitations, storage, and performance is a long ways off.

### Long-Term Memory

Long-term memory differs from STM in involving synaptic changes. Evidence exists that there may be a growth process involved, since the memories are larger than those existing in STM (Shiffrin, 1993). It is well known that memories, when fixed, are extremely difficult to erase. Parts of the brain concerned with memory contain many very small nerve-cells (amacrine cells). These cells may serve to produce an inhibitory substance closing unwanted pathways and allowing for the formation of alternative routes. This might explain why the capacity to change pathways, or to learn, is so widespread in living organisms.

LTM is suggested to be a cortical function of mammals in general. The temporal lobes of the brain are likely to be involved in humans. Recent work (Kosslyn, 1995)

using positron emission tomography to localized memory actions showed that the primary visual cortex was activated when subjects closed their eyes and visualized objects. Other experiments show the influence of other regions of the brain. When chemicals are used to “knock out memory” (Roush, 1997) in the hippocampus, mice lose their ability to do spatial learning. Many of the new studies are focusing on the molecular chemicals thought by researchers to help store new memories in LTM. The process is thought to act by strengthening the electrochemical signaling between neurons. Such molecular chemicals include compounds like alpha-calcium-calmodulin-dependent kinase II (CaMKII), or N-methyl-D-aspartate (NMDA).

In the higher levels of neurological development, there is special nervous equipment which separates advanced organisms from organisms such as worms or insects. In octopuses, for example, there are two anatomically distinct memory centers. In one center are stored records of objects seen. In the other center records of objects touched or tasted are located. Octopuses make decisions, deliberately making choices between alternatives: this is one of the essential features of memory recording. In these invertebrates, the mechanism for memory is localized in the brain. The model for such a unit of memory, called a mnemon, can be an anatomical piece of brain as in the octopus, or a more complex component in humans. No such object, an “engram” as it was named by Lashley (195), has been located in humans. Engrams which link learning and recall have been inferred in humans, not demonstrated.

It is now clear that separate LTM regions exist for words, for vision, for functions such as touch or feel, for sounds apart from the sounds of language, and for aspects of movement. Within these large divisions, there are still finer subdivisions of processing and memory (Gordon, 1995). New research mitigates against the idea of memory being an entity in which each remembered item is stored in a localized fashion. Unlike in a computer, where one need only search and locate the proper address to find the item, many researchers prefer the concept of non-localized or distributed storage (Murdock, 1993; Metcalfe-Eich, 1982, Houghton, 1990; Burgess & Hitch, 1992; Brown et al., 1996). This theory views information as being composed of attributes or features. These attributes are stored at points that are distributed around in non-adjacent areas of the brain (Nilsson, 1984). To put the attributes together requires an associative relationship which allows the brain to recombine the features into a complete unit of knowledge.

Several possible strategies exist for localizing information into LTM. Voluntary elaboration of memory traces is one of the most effective methods (Atkinson & Shiffrin, 1968). However, Craik & Lockhart (1972) noted that desire or intention to store any material seems to make little difference in the ability to transfer data into LTM. Desire or intention acts primarily as a motivational factor. Repeated retrieval of information assists in strengthening LTM traces (Carrier & Pashler, 1992). Elaboration may also help accentuate trace storage for subsequent retrieval. The most common means of studying normally employed by adult learners is that of rehearsal. This obviously does store some

amounts in LTM. But rehearsal alone as a process does not succeed in increasing such storage (Greene, 1987). Surprisingly, material does not have to be stored first in STM before transference into LTM (Shallice & Warrington, 1970).

One explanation for LTM is that of schemata. Schemata are what is held in LTM to allow automatic processing according to Neisser (1967) and Norman and Bobrow (1975):

We believe that the aim of cognitive processes is to form a meaningful interpretation of the world. That is, the sensory information available to a person at any moment may be gathered together and interpreted in terms of a coherent framework. We assume that past experience has created a vast repertoire of structural frames or schemata that can be used to characterize the prepositional knowledge of any experience. The problem of the perceptual processes is to determine the appropriate schemata and to match the present occurrences with the frame provided for them. If there are too many discrepancies, either a new schema must be selected or the current one must be reorganized. (p. 119)

Such schemata are the material held in storage in an organized form for use by the brain for future need. It is these schemata that are damaged, displaced, or lost during the process of forgetting.

### Forgetting

Forgetting is another factor of memory, and a quite pervasive one, given that much information is forgotten on a regular basis. The operative determinants of this trace fragility are unknown. Although numerous experiments have been performed, it is still unclear if forgetting is a fixed feature of STM and LTM, if such decay has a variability factor, or even if the loss of memory is a normal brain function. There are now several

interpretive tools available for analyzing forgetting and its place in the memory process. Most neural network theories argue that activation of trace representations automatically decays with time (McClelland & Rumelhart, 1985). Many studies have suggested that material may be forgotten rapidly even under conditions of minimal interference (Cowan, Lichty, & Grove, 1990). Other researchers argue (Estes, 1972) that LTM simply become less precise with the passage of time (also Bjork & Healy, 1974; Lee & Estes, 1977). According to this latter view, the probability that a bit of information will be retained with respect to other remembered materials changes systematically with time. However, all theories using time as a variable factor have a significant problem explaining the variability that occurs in forgetting as decay occurs over different lengths of time (Houston, 1991).

The most comprehensive alternative to decay theory is the theory of interference, a word originally used as synonymous with displacement (Waugh & Norman, 1965). Interference refers to materials being displaced or removed from the system as new material is entered. The current usage of interference implies either an over-writing by current materials, or an erasing of materials no longer needed (Nairne, 1988). Strong support for this comes from experiments that demonstrate retroactive effect of similar materials in STM (Proctor & Fagnani, 1978). However, neither method, over-writing or erasure, appears to cover all problems. Interference may be a source of forgetting, but not the sole source.

Another mode associated with forgetting processes is deblurring (sometimes called redintegration). This is a process by which STM traces are encoded into a form allowing for no overt recall. In a sense, the material is misinterpreted, and loses all reference to the original meaning. Many experiments suggest deblurring is an important source of forgetting (Brooks & Watkins, 1990; Burgess & Hitch, 1992; Laming, 1992; Schweickert, 1993).

### Retention

The ability to retain information or associations after the practice or learning period has ceased is termed retention. Retention has been studied in terms of: (a) what happens to memories; (b) how quickly do memories vanish; (c) whether or not memories remain implanted in the brain forever; and (d) what factors are important in determining the ultimate rate of memory loss. Recent research (Houston, 1991) has shown that systematic review of information may effect not only the quantity of what is learned but also the quality. Mayer (1983) found that repeated presentations of a science passage resulted in a large increase in recall of conceptual principles, but did nothing to promote recall of technical details. Reviewing material may simply divert the learner's attention away from verbatim details, forcing the formation of deeper conceptual structures. Many researchers agree: in general, additional study opportunities enable a learner to use increasingly more sophisticated encoding strategies based on knowledge obtained in

previous encounters with the material (Amlund, Kardash, & Kulhavy, 1986; Kiewra, Mayer, Christensen, Kim, & Risch, 1991).

Reviewing as a learning and retention technique is complicated by the "spacing effect": two reviews occurring close together in time often are only slightly better in forming a memory trace than that formed from a single study session. Much more effective are reviews that are distributed over lengthier periods of time, an effect demonstrated repeatedly in a variety of text-processing tasks (Dempster, 1988; Glover & Corkill, 1987; Dempster, 1987).

The quantity and quality of retention can be investigated using deficient-processing experiments. The theory behind these experiments is based on four possible mechanisms: (a) consolidation; (b) habituation; (c) rehearsal; and (d) attention. The consolidation hypothesis (Landauer, 1969) proposes that the transfer of information from STM to a more permanent retrievable state takes time. This process can be interrupted if a repetition of the to-be-remembered information occurs prior to consolidation. The habituation hypothesis (Hintzman, 1976) attributes deficient trace formation to a mechanism that adapts or turns off for a short period following input. Under data entry conditions in which large amounts of material are attempting to enter simultaneously, a repetition would receive less than full processing.

The rehearsal hypothesis (Rundus, 1971) argues that individual items spaced over time receive more attention and rehearsals than mass collections of items. Because frequency of rehearsal is directly related to recall, the hypothesis argued that a larger

differential amount of rehearsal increases recall. Some work (Ornstein & Naus, 1978) argues against this hypothesis.

The voluntary-attention hypothesis argues that the subject chooses to pay less attention to repetitions when data are massed than when they are spaced (Hintzman, 1976). The hypothesis assumes that processing of information can be allocated in a flexible way at the learner's discretion. Since there is a dependency on the learner, the student's beliefs, expectations, and preferences directly effects the retention process (Zechmeister & Shaughnessy, 1980). However, some experiments seem to suggest (Toppino, 1991) that the mechanism isn't voluntary. In fact, the operation of an involuntary mechanism that controls attentional aspects of retention is now favored by many researchers (Rose, 1984).

### Rehearsal

One of the processes of an uncertain nature in memory work is the requirement for rehearsal in learning. The problem involves the role of practice: does practice enhance learning? If it does, how does that enhancement occur? In particular, what can be gained by increasing the frequency of practice? Or, viewing the problem from a stimulus-response mode, what occurs in the brain when the response is repeated in the presence of the repeated stimulus? Although it appears obvious that the rule should be "the more practiced, the more learned", reality indicates that the truth is far different!

Many instances have been observed of what psychologists have called the all-or-none learning mode. In this mode, learning occurs completely after one trial, or it doesn't occur at all. Understanding of the process results from a study of learning curves. These curves are visual representations of performance achievement over either a series of trials or carefully controlled and time intervals (Houston, 1991, p. 134). Most curves show a negatively accelerated learning curve: that is, performance drops off with further rehearsal, an observation noted in many areas of investigation. However, a learning curve must be carefully differentiated from a performance curve, which is what is usually shown in learning arguments. Performance curves refers to the activation of learning through the involvement of motivation (Houston, 1991), whereas learning curves refers to the cumulative response over time for information being entered, encoded, and stored.

The idea of rehearsal as an element of learning has a long history. Clark L. Hull (1952) established the idea of a gradual approach to learning in 1952. He found that learning was done incrementally, increasingly gradually as a result of reinforced practice. Hull managed to develop an equation for learning, expressed as:

$$\text{the response probability} = (D \times H \times K \times V) - (I)$$

where the five interacting variables are:

D = drive (equated to motivation);

H = habit (reflects how much the organism has already learned);

K = incentive motivation (refers to the quantity of the goal and quality of the goal);

V = stimulus intensity dynamism (refers to the probability that a response will increase as the intensity of the stimulus increases);

I = inhibition (a fatigue factor, measured in the amount of work involved in making a response and the number of times the response was made).

An alternative to Hull, the all-or-nothing approach to learning, was established by Guthrie and Estes (Guthrie, 1952; Estes, 1959). Their theory argues that a combination of stimuli which have preceded a response will lead to learning. The theory implies that learning will occur completely after a single occurrence of the stimulus-response.

Many researchers have found event repetition to be a robust method of improving memory (Hintzman, 1974). That effect was noted in both recall memory and recognition memory experiments (Jacoby & Dallas, 1981; Donaldson, 1971). Some boundary effects were discovered. If words are used in the study, the spacing of the repeated presentations was critical. Associated memories were better with long time lags (Melton, 1970). In a classic experiment, Hebb (1961) found substantial support for the view that rehearsal is actively involved in the transfer of information into the LTM. Additional experiments have confirmed that relationship (Rundus & Atkinson, 1970; Rundus, Loftus, & Atkinson, 1970).

A significant factor in rehearsal is considered to be the quality of rehearsal, instead of the quantity. Quite often the durability of learned material depends on how the material is rehearsed (Craig & Lockhard, 1972). Merely paying attention to the

physical nature of the various stimuli is considered to be shallow processing, resulting in weak learning or poorly constructed mental traces. A deeper form of processing is considered to be words rehearsed by attending to their sounds. Words can also be considered on a semantic level, representing the deepest levels of processing, resulting in durable, often permanent, traces. Support for this view comes from Craik & Tulving (1975), Moeser (1983), and others who have used the same experimental design involving incidental learning. In this type of experiment, the subjects are never actually instructed to learn the words: the participants are only oriented towards the word lists and informed to make some judgment about individual units.

Other experimenters have trouble with the entire concept of depth-of-processing in learning and retention. There are several criticisms against the concept, including: (a) vagueness and poorly defined contexts; (b) circular definitions of depth-of-processing (Baddeley, 1978); (c) no independent measure of depth (Nelson, 1977); and (d) many important exceptions to the rule requiring deeper processing to form more durable memory traces.

Rehearsal's role in retention has long been recognized. But Craik and Lockhart (1972) have shown there are at least two major types of rehearsal. The first type, called maintenance rehearsal, involves taking information and forming a low-level, transient acoustic code for it. The code can be maintained indefinitely, but there is no transfer to LTM. The second type, called elaborative rehearsal, involves taking input and creating elaborate codes that are stable and later retrievable from LTM.

In summary, the real conclusion regarding retention seems to be that deeper processing can lead to more lasting learning, but that such processing isn't essential in making permanent memory traces. The elaboration hypothesis maintains that semantic processing leads to richer, more varied encoding. This requires more information than just attempting to retain a simple word or concept by itself. The idea of rehearsal is that complex, varied, and substantial information stimuli are stored clearer and deeper in the formation of mental traces. Another approach, called the distinctiveness hypothesis, holds that deep processing tends to help make the datum more distinct from other information in storage, and thus easier to recall (Walker & Jones, 1983).

### Retrieval/Recall

Without the ability to recall learned material, humans would not be in the position they currently hold in the animal kingdom. It is that ability to retrieve memories and re-use them in future circumstances that separates us from the other forms of life on earth. In studying recall or retrieval, it has become clear that memory is much more than just recall of past stimuli. It involves human notions, will, and creativity in the reconstruction of the past to serve present needs (Coleman, 1986, p. 9). Many authors agree with Pear (1922) that the mind does not work as a camera taking durable photographs, but rather paints pictures. Many researchers argue that events and personal experience can only properly be understood and appreciated in retrospect, during remembrance.

Retrieval processes refer to the means of accessing and using stored information. They are also inextricably bound to those modes of encoding and storage. How a learning event is encoded and stored determines how well it can be retrieved later, and what necessary clues will be required to effect the retrieval. Surprisingly, little was done on this until the mid-1960s. Now wide variations of studies are used, including:

(1) repeated testing (Erdelyi, 1984; Roediger & Challis, 1989); (2) presentation of cues at test; (3) judgments made during retrieval; and (4) comparison of different instructions at retrieval (Jacoby, 1991).

Several interesting principles involving recall memory have been discovered. Retrieval rates increase when there is a match between processing activities used during initial encoding and those activities used during retrieval (Bransford et al., 1979). Similarity between encoding and retrieving processes is critical (Tulving & Thomson, 1973). The more information contained under a single retrieval cue, the less likely will be the recall for any one piece of information (Watkins, 1979). In addition, the more distinctive the datum, the better remembered it is. Most researchers now adhere to this encoding specificity hypothesis as the principle governing the effectiveness of retrieval. Many experiments have shown that a retrieval cue will be effective if, and only if, it reinstates the original encoding of the to-be-remembered event (Thomson & Tulving, 1970). The rule appears clear: the probability of successful recall or recognition of a previously encoded material depends on the extent to which mental events and processes of recall approximate those occurring during input (Eysenck, 1977, p. 95).

Retrieval, especially from working memory, must be, in part at least, cue dependent. The memory trace is used either to assure the most appropriate response or to assist in making decisions. Taken for granted in LTM, the involvement of recall memory is less well understood for STM (Hintzman, 1988; Raaijmakers & Shiffrin, 1981; Lewandowsky & Murdock, 1989). Work by Sternberg (1966) suggested the retrieval from working memory is controlled by a serial process. Later work (Ratcliff, 1978) found evidence for a parallel process, in which the probe used was comparing all the maintained items at the same time. At present, the evidence is quite contradictory, especially when using mean reaction time as a variable of study (Ashley, Jain, & Balakrishnan, 1993; Townsend & Ashby, 1983). Most researchers (see McElree & Doshier, 1993) opt for some kind of parallel process for retrieval of individual item information, whereas recovery of ordered information involves a slower serial retrieval process.

In daily life, there are in fact two types of memory that are interchangeably referred to as retrieval. These include recall memory and recognition memory. To recall something, the individual must bring the to-be-remembered information together in the brain and combine it into a useful, usually speech-oriented, form. How well material is recalled depends on the adequacy of the clues given or deduced, and the way the information is reconstructed in the mind. Recall also depend on how easy it is to express that to-be-remembered information in the first place ( Gordon, 1995, p. 30). Recognition memory, however, tends to be less open-ended. Recognition is used by the brain for

searching for a connection between possible answers that are already available, one that makes the most sense. The brain does not have to do a virtually unlimited search with a minimum of cues to locate the correct answer. Recognition memory and recall memory appear to probe different kinds of memories in different fashions.

A recall effect dealing with STM is that of retrieval priming, which occurs in the absence of conscious awareness. For example, reaction times to the word PILOT are faster if the term AIRPLANE had been presented. In this experiment, the word is presented at perceptual levels only, where no conscious detection occurred (Merikle & Reingold, 1990). The ability to identify a briefly presented word, in a minimal length of time, is greatly enhanced by its prior presentation (Jacoby & Dallas, 1981). The result of this experiment is that conscious awareness is not, and can not, be a necessity for increased accessibility to encoded information. Retrieval priming has been detected for days after a learning event (Tulving, Schacter & Stark, 1982). If memory is considered to be working activation of firing patterns within the brain as most researchers believe, coded in terms of increases or decreases in firing rates relative to a baseline for the nerve cells (Carlson, 1991), the entire idea of a STM store may be wrong, or vitally incomplete. There is even growing evidence that information can be stored in the memory in a state of extremely low firing rate activation. Such memories can be inhibited or become less accessible than normal as a consequence of the retrieval of other memories (Bjork & Bjork, 1996).

There are several phenomena associated with recall or reminiscence that complicate understanding the mechanism of retrieval. In the phenomenon of hypermnnesia, information that had been forgotten, or could not be recalled, can be retrieved later without any intervening opportunities for learning (Ballard, 1913). Apparently such retrieval increases under some circumstances after longer time periods following acquisition (Erdelyi & Becker, 1974). A second phenomenon is referred to as incubation. This involves the non-deliberate, usually sudden occurrence of an idea or solution to a problem following a previously unsuccessful search for the solution (Posner, 1973). In many instances, delays actually improve the ability to solve particular problems. Unfortunately, such delays are subject to a variety of different variables, so that only anecdotal evidence is presently available. A third phenomenon is termed "mind-popping". During this event, information is retrieved although there is no deliberate attempt to recover the material. This phenomenon occurs quite often in finding solutions to persisting problems. Often very creative solutions come to mind unintentionally and quite unexpectedly (Berry & Broadbent, 1988).

A last function of remembrance is one used extensively by the aged. Some researchers (Moscovitch & Winocur, 1992) see increased reminiscence as a manifestation of the process of aging. In elderly persons, remembrance serves a function in identity maintenance. People rework the past to keep a continuity with it: "Like the life review, it involves considerable effort and reorganization, but rather than reconciliation with one's personal past, such reorganization is the creation of an image. It serves, we believe,

to resolve a critical dilemma posed by the issues of old age and leads not to serenity but rather to stability” (Coleman, 1986).

### Prior Investigations of Memory Training Techniques

Numerous techniques have been used in education for assisting students to learn. Although some techniques are almost universal, there is no particular evidence indicating the general success of any of these techniques. Underlining, and its equivalent companion of high-lighting, were found to produce no significant differences in learning ability or memory when compared to just reading (Idstein & Jenkins, 1972). In another study, reading was found to produce better results than either technique (Houston, 1991). One conclusion was that underlining should be used only sparingly and judiciously to have any real value. Other sets of studies (Stordahl & Christensen, 1956) found no differences in memory abilities among students who engaged in either summarizing, underlining, outlining, or reading and re-reading during objective tests of simple recall memory, recognition memory, or concept comprehension. Researchers found reading or re-reading to be superior to summarizing (Houston, 1991). These study techniques all were shown to be less successful learning techniques than those techniques often associated with mnemonic methods. Such memory techniques as narrative stories (Kosslyn, 1994), pegwords (Lorayne & Lucas, 1975), the method of loci (Bellezza & Reddy, 1978), and the use of key words (Atkinson & Raugh, 1975), are all based on visualization and visual imaging.

The use of visual-spatial representation studies are numerous (i.e. Loftus & Ruthruff, 1994; Baddeley, 1992; Freyd, 1993; Hegarty, Carpenter, & Just, 1990; Kosslyn, 1994; Roskos-Ewoldson et al., 1993). These experiments provide abundant evidence that forming mental images can enhance performance in a variety of learning and memory tasks. On an experimental level, a major finding has been that concrete or high-imagery words are better retained than abstract words. These results have been obtained from studies of paired-associate learning, free recall, serial learning, and recognition memory (Paivio, 1971). In the last twenty years, investigators have focused on analysis of the properties, nature, or significant format of image representations in memory, as well as the conditions under which mental images are likely to be used. For example, Shepard and Metzler (1971) investigated image "mental rotation". In these experiments, the subject imagined one object rotated until it lined up with another provided object picture. These experiments indicated that images could be transformed through a process that was a mental analogue of an external physical action ( i.e. rotation). Most importantly, the investigators found the imaging process was used spontaneously in accomplishing the comparison task. Such rotation experiments were used to assess what form of location information is encoded in mental images (Cave et al., 1994), and to investigate whether single-view-independent or multiple view-dependent representations of object are employed for memory comparison (Tarr & Pinker, 1989). In similar experiments, other variables studied included size comparisons (Bundesen & Larsen, 1975), types of symbols used (Just & Carpenter, 1985), the synthesis of whole figures from individual

parts (Palmer, 1977), complex sequences of transformations (Shepard & Feng, 1972) and mental scanning and recall of maps (Kosslyn, Ball, & Reiser, 1978).

The current debate on imagery usage involves whether mental images are depictive (i.e. like pictures) or descriptive (i.e. tightly linked to, and accessed by, meaning) representations. Arguments against the depictive position include Hinton's (1979), who showed people are limited in their ability to read information off a depiction, and Jastrow's (1900) findings that many figures are ambiguous, with multiple interpretations possible. Other work, including the use of ambiguous duck/rabbit figures, supports the descriptive position (Chambers & Reisberg, 1992). Works by Finke et al (1989) and Peterson et al. (1992) strongly seem to favor the depictive view of imagery. But experiments by Bandimonte & Gerbino (1993) find the opposite.

A different view of imaging is that the images are functionally equivalent to visual-spatial representations derived from perception (Finke & Shepard, 1986; Shepard & Cooper, 1992). Memory for such visual representation stimuli has been studied in numerous experiments (Shepard, 1967; Standing, Conezio, & Haber, 1970). The outstanding result has been the high success rate, up to 95%, for correct recognition memory of pictures. In general, investigators have shown that pictures have a definite superiority effect in memory trace problems, essentially being much richer in information than simple word usage. Picture codes can be much more complex and comprise more encoding components than word codes processes (Mandler & Johnson, 1976). Since complex codes with numerous mental associations are shown to be

remembered more clearly, forgotten more slowly, and processed more rapidly, visualization can contribute greatly to memory ability enhancement (Kroll & Ranskov, 1984).

A variety of factors are responsible for the superior recall of pictures and of high-imagery material. These factors may include: (1) dual-encoding, the hypothesis of Paivio (1976) that requires both image and verbal encoding for multiple organization and easier access to items; (2) the fact that pictures in general are more easily organized into thematic structures than words are (Rabinowitz & Mandler, 1983); (3) the idea that pictures are more specific, and provide more concrete memory codes than do words; and (4) the belief that imagery is likely to encourage more meaningful, elaborated representations (Belmore, 1981).

Which kinds of images are best? Some research (Bower, 1970; Robbins, Bray, Irvin, & Wise, 1974) suggest interactive images are stronger than non-interactive images. However, there appears to be a limit on the number of interactive images (Begg, 1978). One strong interactive image helps retain material just as multiple interactive images (Day & Bellezza, 1983).

To summarize, mental images of material to be learned, whether the material be words, ideas, concepts, or an inter-mixture of abstract material, tends to preserve in the brain the basic quantities of the material. Internally the encoded data is transformed into mental traces that show a functional equivalence to the real world objects. The formation of memory traces results in the activation of different sectors of the brain. Retrieval at

some future date is possible without significant loss of detail or integrity by an integration of the traces acquired by merging the mental images from the different areas.

Numerous studies have been performed on organizational techniques that are designed to enhance memory. Techniques studied include: (a) narrative chaining (Bower & Clark, 1969), in which word lists are learned serially (those individuals using chaining retained 93% of the words while non-story groups recalled only 13%); (b) imagery linking (Bower, 1972), in which objects are linked together by visual pictures; and (c) subjective organization (Mandler, 1967; Tulving, 1966), where the subject does the grouping of the words or items to be remembered.

As a result of detailed studies of memory (Kulhavy et al., 1983, p. 135), applications of memory techniques are seen to be governed by three important principles:

(1) the allocation of processing attention is critical in order for encoding to take place. Any procedure that directs processing attention to target portions of the instruction increases the probability of learning;

(2) the activation of appropriate knowledge schemas provides a useful semantic framework for interpreting incoming data. Any manipulation which acts to produce an interpretation schema that is similar to the scheme operating at the beginning of the instruction will heighten the chance of the contents being successfully encoded;

(3) the depth of processing, in terms of both effort and complexity, is important for producing durable encoding. Any instructional method that compels the student to

work harder at learning, or helps to semantically increase the elaboration-integration process, will lead to more effective instructional outcomes.

It has been known for a long time that mnemonic procedures are valuable in classroom teaching. A wide range of activities, from tying a string around a finger to more elaborate procedures, are all referred to as mnemonic devices. As a group, the techniques are defined (Loftus & Loftus, 1976) as "... a technique (often referred to as a memory trick) for organizing information so that it can be more easily remembered" (p. 64). Norman (1976) added a qualifying remark: "They teach the user to pay attention and to learn how to organize" (p. 131). There are, however, many questions as to how effective self-initiated mnemonic strategies are (Higbee, 1988; Levin, 1981). More incisive and extensive analyses of the operations of mnemonic devices are needed (Bellezza, 1981).

There are a number of reviews on uses of memory training techniques (Bellezza, 1981; Higbee, 1988; Mastropieri & Scruggs, 1991; Paivio, 1971). In general, mnemonic techniques are divided into encoding processes and organizational processes. For both types of processes, mental cues, often in the form of visual images, are created to make retrieval more successful. In organizational processes, the learner must first memorize a set of mental cues. These become part of the learner's repertory of memory locations, to be used as needed. Examples of organization mnemonics include the method of loci (Patten, 1990) and the pegword method (Miller, Galanter, & Pribram, 1960; Higbee 1988). Encoding mnemonics also used cues. But unlike in the organizational processes,

these are created during the memorization process to act as substitutes for information that is either low in imagery or meaningfulness. These substitute pictures must be semantically or phonetically similar to the material to be learned to have any value in representing that information in memory storage (Bellezza, Day, & Reddy, 1983). Such continual creation methods include story mnemonics (Bower & Clark, 1969) and the various link method (Bellezza, 1991). These techniques encounter problems because if any one picture in the linkage is lost, the rest of the words or concepts can be adversely affected.

The use of such mnemonics in encoding and organization generate memorable representations. These can be conveniently and logically organized in the LTM storage area. The advantage of these techniques is in allowing for memorizing and learning materials that are either difficult conceptually or are highly abstract in nature. For example, a common complaint is remembering the names of people when they are first introduced. The problem is compounded when the names are non-descriptive or nonsense words (i.e. having no definitional base outside their usage as a name). Techniques for encoding of a person's name and associated facial features are available (Lorayne, 1975; McCarry, 1980), but little research work has been done. More research has been done on memorizing numbers (Bellezza et al., 1992), using what is referred to as the "digit-consonant mnemonic" (Higbee, 1988). These experiments involve mental techniques resulting in the formation and association of pre-arranged mental representations of the to-be-remembered numbered material. This process is known as

cue-based learning (Tulving, 1974), in which the cues are essential for recall by of the principle of encoding specificity. An extremely important perspective regarding such cue-based learning is that the location of a memory trace taking place during recall can be thought of as re-activation of the context accompanying the original learning: the original memory trace activation is a private and individualized matter. For each individual, the clearer and stronger the cues, the easier, more accurate, and fuller the recall. It has been shown that mental cues that are constructed using such cueing (Tulving and Thomson, 1973) are easily retrievable from memory during two critical times in the learning process: (a) during study, and (b) during recall. This idea of memory trace constructibility suggests that a set of mnemonic cues, such as those used in the method of loci, is really a knowledge structure implanted in memory (Galambos, Abelson, & Black, 1986).

Another important factor, along with constructibility of cues, is that of associability of information traces. Mental cues must be associated to new information being learned: the greater the number of features, attributes and associations activated as part of the cue, the more associable the cue will be and the easier will be retrieval (Underwood & Schultz, 1960). Such mental cues are most easily done in visual form, so all classical mnemonic procedures place great emphasis on creating vivid visual images (Patton, 1980). This reduces the problem of discriminability in learning, in which the ability to separate mental cues from each other becomes essential for recall. If cues can't be discriminated easily during learning, interference occurs through cue overload

(Watkins, 1976). The management and organization of memory involves optimizing the load on memory cues. Associability of mental traces is also important for the ability in the learner to be able to go from a cue to the desired information, or from the information to the cue. This is referred to as bi-directionality. The ability to remember from two directions greatly enhances learning, as the material is much easier to retrieve when it can be accessible from more than one direction. Mental cues in the form of visual images usually result in bi-directional associations (Mastropieri, Scruggs, Bakken & Brigham, 1992; Paivio, 1971). This has a substantial value for retrieval. Besides activating the material structure in memory and the processing strategy (Hunt & Einstein, 1981), information representing this new event in memory is now forming new associations, providing even more contextual information for ease of retrieval. Such contextual information may be important when recalling information learned employing a multiple use organization mnemonic such as the method of loci. All these mediating concepts are basically elaboration of the material to be retained. The elaborations are mediators for learning, providing for the proactive facilitation of retrieval. These techniques, used with encoding, ensures that a meaningful mental cue exists for each piece of information memorized.

A number of researchers have defended the use of mnemonic procedures in the classroom (Higbee, 1978; Levin, 1981; Bower, 1970; Mastropieri & Scruggs, 1991; Scruggs & Mastropieri, 1990). Work on memorization seems essential from their investigations, since, if nothing else, vocabulary must be memorized to understand and

deal with other information. Unfortunately, American education has traditionally de-emphasized the learning of useful techniques and skills, concentrating on the memorization of factual information. Educational theorists now are stressing the teaching of knowledge-free thinking and problem-solving techniques. However, it seems these cognitive processes cannot be taught to students who do not already possess an extensive knowledge base (Glaser, 1984; Kyllonen, Tirre, & Christal, 1991). A major component of thinking seems to be the possession of accessible and usable knowledge.

It is known that comprehension of what is read and observed depends on the activation of organized knowledge structures in memory. The knowledge base, used to make inferences, draw conclusions and retain new information, is built up slowly at first. As more knowledge is organized in memory, learning and comprehension can take place much more rapidly. To facilitate this, it seems desirable to find ways to enhance memory skills useable in the acquisition of knowledge.

## CHAPTER 3

## METHODOLOGY

In this study, it was hypothesized that the memory ability of students with poor, average, or unused memory skills as defined by the SKILLS instrument could be substantially improved by the introduction of a variety of memory enhancing techniques. Most of the skills introduced were centered around processes of visualization, element linkage, and structured recall. This is in agreement with the ideas of Seamon (1980) and Zechmeister and Nyberg (1982). They showed that the manner in which material is organized and processed is particularly important in making extremely durable and easily retrievable memory patterns, with the deeper the processed stimulus the better. A flowchart of procedures, advancing from the simplest techniques and involving the use of mental visual image formation and linkage was provided the participants so they could see what procedures were to be introduced at a later date. Formation of mental images were focused on since it has long been known that materials in the form of pictures were much more easily recalled than mere words. One of the elements of these techniques had the student manipulate images as recommended by Adam and Aker (1982) who showed that any learned, manipulated information is retained vastly longer than verbal information under any sort of circumstances. Training proceeded through the most complex strategies which involved formulation of structured recall patterns and mental

mappings. The techniques illustrated and discussed provided each student a diverse variety of offerings sufficient to allow each individual to find elements adaptable to his/her own situation, in conjunction with their already developed (i.e., lacking or unused) memory skills.

The total time involved in the training sessions was twelve hours, done in three hour blocks. The duration of training time was based on prior memory workshops given at the University of Great Falls in which twelve hours was found to be the time necessary to adequately cover the multitude of topics presented. The four class sessions were based on the time available for both the instructor and the students during the regular semester class schedule. Students were advised to drill on the presented materials for a minimum of one hour per day on their regular school class materials. In addition, there were materials passed out in class for practice on specific memory techniques. The total time for each participant, including class attendance and home practice, was forty hours.

Under this tutelage, it was hypothesized the students involved in the study would be able to not only apply the techniques demonstrated but also would be able to adapt or modify generalized techniques to memory exercises or problems specific to their own circumstances at a future date. This metamemory -- understanding how memory skills capacities work and what an individual must do to remember material effectively -- was involved in: (a) changing student attitudes and awareness about their own abilities; (b) setting up categories, strategies, and rules for learning and remembering; and (c)

instilling in the student the ability to pick out the appropriate memory technique to be used with the particular material that is necessary to be memorized.

Questions dealing with the efficiency of such training were investigated by providing actual training to students on a variety of memory techniques useable for increased long-term retention of material. Using pre-tests and post-tests would indicate whether or not the students could develop the ability to manipulate techniques that were appropriate for retention of any form of material. In addition, the techniques taught would enable the student to develop the ability to concentrate completely on the material presented. One of the largest problems learners deal with is that of concentration, rather than allowing the mental processes to wander over a host of unrelated topics or information (Dagenbach, 1994).

The program taught included basic memory ideas, including: (a) the formulation of mental imagery, (b) development of attention and concentration ability, (c) improvement of comprehension levels, and (d) the development of techniques useable in making long-term retention of material easier and more retrievable.

#### Design

This research used forty participants who were students at the University of Great Falls and at Montana State University-College of Technology. Individuals came from a variety of disciplines and occupations. These majors are listed in Table 1

Table 1. Study Participants by Major

Student Major	Number Participants
Nursing	2
Para-legal	2
Criminal Justice	3
Biology	2
Chemistry	1
General Science	2
Education	2
Respiratory therapy	2
Mathematics	1
Accounting	1
Sociology	2
History	1
Counseling	2
Computer sciences	1
Physical Education	1
Undecided majors	15

A number of the students were also employed in occupations and were furthering their careers by continuing their education, or were taking courses in anticipation of a career change. The occupations listed included three students in the military, one student in the police force, one secretary in administrative support, one student in speech pathology, one student in respiratory therapy, one student in business, and one student in physical therapy. Three faculty members from the two schools were included, including a Professor of Accounting, a Health Professions Department Head, and an Instructor in Respiratory Therapy. Finally, three housewives (as they listed their occupations) were also members of the study.

The study group of participants were derived from those students who completed the SKILLS instrument and then volunteered to participate. All students taking the test that wished to participate were allowed in the program, but attention was focused on those producing low scores on the SKILLS instrument. Forty students were involved in the study. Students with high SKILLS scores were used for comparison of the effects of the training on students who already were making more use of memory skills previously developed during their life

The preceding categories of students were useful for this study for several reasons. First, they represented a fairly broad spectrum of students typical of a college or university, with different needs, motivations, and reasons for undertaking such a course of instruction. Secondly, so many different categories were selected to insure that a diverse make-up of learning styles were represented in the study. Since, according to Kolb (1981) learning style is partially related to the profession that one is in, the variety of student types increased the probability that all learning styles would be involved.

The research was a descriptive case study involving both qualitative and quantitative methods of data gathering. A case study is "an intensive, holistic description and analysis of a single entity" (Merriam, 1988, p. 16). Such case studies allow the investigator to focus on a single situation, case, or phenomenon, in this case memory ability and development. By using qualitative methods in the case study, in this case the SKILLS instrument, the Kolb Learning-Styles Inventory instrument, and interviews with the participants, the researcher had the ability to use a variety of data collection and

analysis techniques, allowing for construction of a detailed description of the phenomenon being concentrated on. By implementing quantitative methods, in this case the t-tests, numerical analyses were also performed on basic data, resulting in a quantitative comparison of the test results generated from the research.

Qualitative methods were implemented due to the nature of the investigation. Since the results expected were dependent on the diversity of backgrounds involved and the context of the situation under which the learning occurred, this limited the ability of the researcher to generalize from the available results. In other words, unlike more controlled experiments in which the variables can be reduced to a single determinant, any generalizations or extrapolations would need to be carefully considered, related to particularly groups of approximate composition to the group used in the study.

Ultimately, qualitative methods were considered essential for this study because of the types of questions being considered in this research. Basically, all the questions were derivable from a simple "why?" For example, why do some techniques seem to work better than others? Why do some individuals find learning memory skills quite stressful, perhaps even more so than the process of learning itself? Why does there seem to appear to be a relationship between memory skills and learning styles? It has been well established (Merriam, 1988) that such questions require the use of qualitative methods of investigation.

Both qualitative and quantitative methods were applied in this case study to investigate the student's current abilities as compared to their final abilities after the

training had taken place. Further, the study explored the students' own perceptions of their memory skills and how such perceptions changed over the course of the training provided. Data was obtained through personal interviews with each of the study members. Initial data on the participants was obtained by use of the Self-Knowledge Inventory of Lifelong Learning Skills (SKILLS). Learning styles were investigated by use of the Kolb Inventory. Finally, students were qualitatively evaluated by a series of pre-tests and post-tests on memory abilities.

Three primary methods of data collection were used in this study. During the first and last weeks of the training period, tests were given generating numerical results. Also during those two weeks, the initial questionnaire and the Kolb Learning-Styles Inventory (LSI) were done. Students were observed during the entire four weeks, with field notes taken on problems arising during the training sessions and comments made both during the training sessions and during individual discussions.

During the interviews with each student, field notes were taken in abundance. With particularly revealing or detailed answers, the discussion was taken down verbatim to ensure accuracy. Although audio recordings were tried, the majority of students preferred not to be audio taped, feeling it added undue stress to the interview.

InstrumentsSKILLS

The Self-Knowledge Inventory of Lifelong Learning Skills (SKILLS) was used to identify the level of use of memory learning strategies of each participant in the study prior to the beginning of training in memory skills. The SKILLS instrument and the associated evaluation techniques, with an example, is given in Appendix C. The SKILLS instrument involves a series of six scenarios from real-world situations that the student reads and evaluates on how to handle or research further information on the particular problem presented in the scenario. The SKILLS inventory tests on five components -- metacognition, metamotivation, memory, critical thinking, and resource management. However, the only part used for this project was that involving the use of memory. The learning strategies involved in the memory component include: (a) organization, (b) external aids, and (c) memory application. The SKILLS inventory test is a valid and reliable instrument (Conti & Fellenz, 1991) for determining levels of memory ability, with both construct validity, established by literature reviews and judgments on the constructs from a group of adult education and educational psychology professors, and content validity, established by field testing of SKILLS since it cannot be expressed quantitatively (Gay, 1987, p. 130), well determined. Reliability of SKILLS was done by use of correlation equivalencies with values given in Conti & Fellenz

(1991, p. 71). Numerous studies have been done using SKILLS (Hays, 1995; McKenna, 1991; Strakal, 1995; Yabui, 1992; Conti & Kolody, 1995).

In the SKILLS model, memory strategies associated with real-life learning are categorized as organization, external aids, and memory application. Organizational strategies deal with the processing of inputted information in a variety of ways designed to augment the storage, retention, and subsequent retrieval of information, and include such techniques as mnemonics, creating complex mappings, and elaboration of information. External aids are tools outside the brain used to augment the memory process, such as appointment books, or tying a string around a finger. Finally, memory application strategies are those designed to plan and carry out learning. These techniques include practice, reflection, or remembrances, and are identified in SKILLS by seeing how the individual uses memory to avoid repeating mistakes, knowing what to expect in a particular situation, and allowing for the planning of methods of attack in learning materials.

#### Kolb Learning Strategies Inventory

The Kolb Learning Style Inventory (LSI) was created to assess individual orientations toward learning. The LSI is in a self-description format, in the belief that styles of learning rely heavily on conscious choice and decision. It was chosen because self-image descriptions are more powerful determinants of behavioral choices and decisions than are performance tests.

The questionnaire included a twelve-item set of questions. Each item asks the student to rank order four outcomes in a way that best describes his or her learning style.

A sample question would be:

I learn best when:     I trust my hunches and feelings.  
                               I listen and watch carefully.  
                               I rely on logical thinking.  
                               I work hard to get things done.

One word from each item corresponds to one of the four learning modes. These are concrete experience (sample word: feeling), reflective observation (sample word: watching), abstract conceptualization (sample word: thinking), and active experimentation (sample word doing). The LSI then measures the student's relative emphasis on each of the four modes of learning. Scores for each learning mode are derived simply by adding the appropriate numbered answers at the completion of the instrument. In addition, the study uses two combination scores indicating the extent to which the student emphasizes abstractness (AC) over concreteness (CE) in the form of a simple difference (AC-CE) and the extent to which the student emphasizes action (AE) over reflection (RO) in the form of another simple difference (AE-RO).

The four modes of learning are related in the fashion show in Figure 2. The vertical column proceeds from Concrete Experience at top to Abstract Conceptualization on the bottom, while the Active Experimentation lies to the left on the horizontal column with the Reflective Observation on the right of the line (Kolb, 1985).

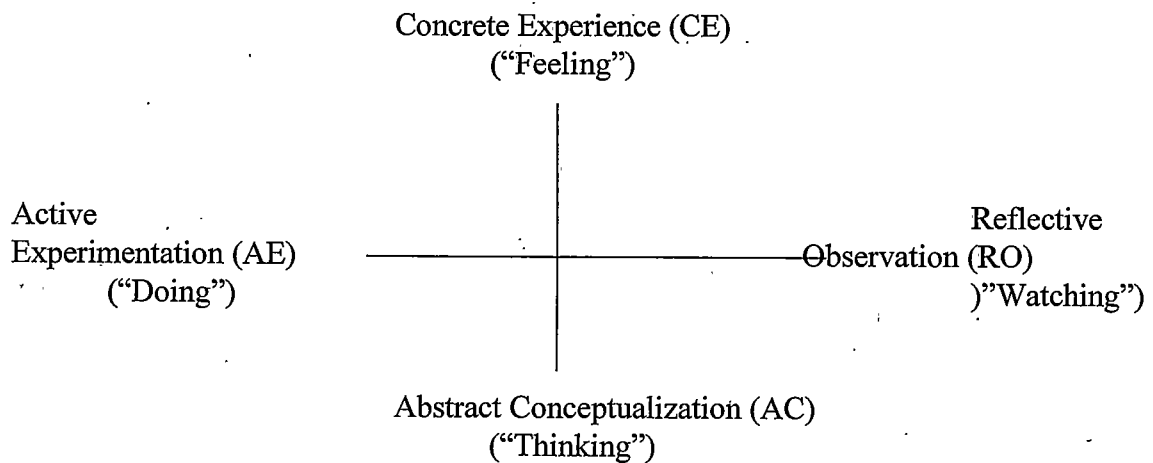


Figure 2. Kolb's Learning Styles.

Most students find that no single mode entirely describes their learning style.

This is believed to be because each person's learning style is a combination of the four basic learning modes. Kolb (1985) ascertained that in combining the scores, there was four learning-style types best described for the student. These are:

**Converger:** combines learning steps of Abstract Conceptualization and Active Experimentation. People with this learning style are best at finding practical uses for ideas and theories. Students here have the ability to solve problems, and make decisions based on finding solutions to questions or problems. Such skills are important to be effective in specialist and technology careers.

**Diverger:** combines learning steps of Concrete Experience and Reflective Observation. People in this learning style are best at viewing concrete situations from many different points of view. The approach taken to situations is to observe rather than take action. Students here enjoy situations that call for generating a wide range of ideas, as in brainstorming sessions. They are identified by having broad cultural interests and like to gather information, with imaginative ability and sensitivity to feelings needed for effectiveness. Careers in the arts, entertainment, and service areas are indicated.

**Assimilator:** combines learning steps of Abstract Conceptualization and Reflective Observation. People with this learning style are best at understanding

a wide range of information and putting it into concise, logical form. Students here are less focused on people and more interested in abstract logical soundness than practical value. These students would be effective in information and science careers.

Accommodator: combines learning steps of Concrete Experience and Active Experimentation. People with this learning style have the ability to learn primarily from "hands-on" experience. They enjoy carrying out plans and involving themselves in new and challenging experiences. The tendency is to act on "gut" feelings rather than on logical analysis. This style is effective in action-oriented careers such as marketing or sales. (Smith & Kolb, 1985).

Graphically, the student could see his or her own score by plotting the combination scores, derived as:

$$(AC) - (CE) = \text{vertical score} \quad \& \quad (AE) - (RO) = \text{horizontal score}$$

on the graph depicted in Figure 3:

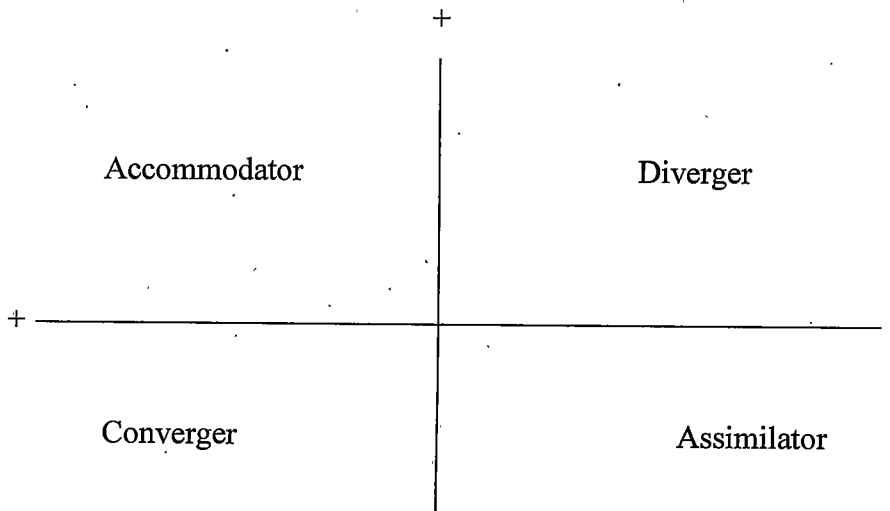


Figure 3. Kolb's Dominant Learning Styles

On the graph, negative values for the (AE) - (RO) axis lie to the right of the center point. Negative values for the (AC) - (CE) axis lie on the top of the center point.

Kolb's LSI was chosen for this study for several reasons. The validity of the instrument has been supported in numerous studies (Wilson, 1986; Katz, 1986). The instrument provided an easily-used tool for investigating the effect of learning style on memory ability, or the extension of such memory skills by instruction and demonstration. For example, in dealing with the components of learning style, individuals who enjoy working through memory problems and solutions showed a tendency towards Concrete Experience. Students who enjoy trying new methods, no matter how difficult they seemed, showed a penchant for Active Experimentation. Reflective Observation could be noted in students that showed a hesitancy towards trying the new methods, instead continuing to fall back onto older proven techniques until a suitable time of thinking about the new methods had occurred. Abstract Conceptualization would be indicative of students who preferred the more abstract forms of memory manipulation, such as making of mental maps or doing recall diagrams

#### Memory Training Instructions

The actual training involved introducing the students to various memory techniques used to increase long-term retention of material. The overriding technique was designed for the facilitation of the use of visual imagery and the development of the ability to make notable (i.e., ridiculous, exaggerated, or memorable) pictures. A second complementary technique involved tying the pictures together in a structured fashion so that students were able to approach retrieval from any possible direction. A flow chart

of techniques was generated that detailed how the techniques were interwoven, how one led to the next, and how a student could tie techniques together based on the types of material to be remembered (e.g., numbers, words, phrases, or concepts).

The training was based on the assumption that memory skills could be developed via the application of well-ordered techniques ranging from simple to highly complex. By presenting the techniques in an sequence that allowed the student to build on previous knowledge, the student should be able to refine the ability to see which techniques are appropriate for certain materials and how such techniques could be modified for the particular circumstances the material presents. The techniques presented to the students were intended to facilitate and focus their ability to concentrate fully on the subject matter at hand rather than allowing the mental processes to randomly gather information and store it in a virtually non-retrieval form. One of the basic principles of Gestalt psychology was to become apparent through the instruction: increased concentration will lead to better understanding and that this in turn leads to higher comprehension rates, aids in developing a more positive attitude, and leads to better memory enhancement.

The training experience lasted four weeks, with meetings once each week for a period of three hours. Thus, there was a total of twelve hours of total instruction. During the time, the diverse techniques were discussed, demonstrated, and applied to sample materials (such as a listing of the states, the presidents, amendments to the constitution, and a wide variety of others) by each student. Practice exercises were given to the students to work on during the week between sessions and the desirability of applying the

techniques to their present learning situations (i.e., school work, business needs, or life experiences) was emphasized. A desired practice level of at least one hour each day was emphasized.

### Quantitative Evaluation

Each of the students involved in the project filled out a brief questionnaire (presented in Appendix B) on their use of memory as they perceived it, prior memory instruction, and their beliefs about their memory abilities. On the first day of instruction, after a brief introduction on the history of memory studies, they were administered a series of brief tests under time constraints. The tests involved : (a) word lists; (b) word order; (c) numbers; (d) events; (e) correlated date items; (f) name and feature identification; (g) a short essay with associated questions; and (h) an essay from which they were to extract, with no associated assist aides (i.e., leading questions) the basic major points. Sample tests are displayed in Appenddix 2. Answers were tabulated and recorded as to total correctness and item completion.

At the conclusion of the four-week training sessions, the students repeated the testing procedures performed during the first session, again under time constraints. The same types of materials in a parallel series of exams were given. Comparisons were made with the original scores for indications of improvement in specific areas and for specific techniques. In addition, to test the long-term memory effectiveness of the training, students were asked to briefly write down the itemized materials that were used

for demonstration and application during the first two weeks of class; there was no prior warning that this feat of recall would be occurring. All of the students were asked to fill out the Kolb LSI questionnaire during the second week of class instruction. The training sessions were followed by personal interviews for each student, focusing on their current beliefs as to their memory abilities, the usability of the techniques learned, their ability to apply the techniques to practical situations, and the usability of the class experiences. Each student had at least a half hour discussion with the instructor, elaborating on the answers and providing for an opportunity to discuss the value of the learning experience and any changes -- positive or negative -- that the student felt might be of benefit to the future presentation of the class.

The analysis of the pre-test and post-test data was performed using t-tests. T-tests were used to compare the means of the groups in the form of correlated samples t-tests because for this study the same group of subjects were to be measured twice, once before and once after a common experience. Each score in the first group was logically tied to a specific score in the second group, because it was obtained from the same person. The basic research question makes use of the null hypothesis, which is an assumption that no difference exists between the two population means (Huck, 1974, p. 52). If the two sample means are far enough apart, the t-tests will identify a significant difference, allowing the conclusion that the two populations probably do not have the same mean and allowing the researcher to reject the null hypothesis in each test case.

Interview Questions

To investigate the problems with instruction of memory skills, the following questions were used during the interviews with the students:

1. What were your overall impressions of the success of the training?
2. Which technique or techniques did you find the most successful for use by yourself? Why do you feel that way?
3. Which techniques did you find the most difficult to implement? Why?
4. Why do you think the techniques that worked best for you did so, while the ones working the least were not useful?
5. Did the training carry over into your regular school work or occupation?
6. Did you find the instruction confusing or a hindrance?
7. What in particular did you like about the training?
8. Did you find the training sessions intimidating? How so?
9. Are there any advantages you see such memory training providing you?
10. What disadvantages did the training have on your learning ability?
11. Do you feel your motivation for the workshop was adequate to allow you to gain the most benefit from the training?
12. Do you think your current memory skills are better than before the training?
13. Do you think your enhanced skills will benefit you in school or in you job?

In regards to the LSI questionnaire, several additional questions were asked:

1. Are you hesitant to try new things such as this memory workshop?

2. Do you prefer dealing with concrete reality rather than flights of fancy?
3. Do you like "hands-on" experiences over abstract, mental ones?
4. Do you like to participate, or do you prefer quiet meditation on your own?

The questions discussed in the interviews with each student were open-ended, to allow participants to give as much or as little feedback as they preferred on each question. For example, some individuals preferred straight "yes-no" answers, with very little elaboration on any of the questions. Others spent more time discussing why they felt a particular way, without ever giving a definite "yes-no". In general, the more educated the individual, the more discussion he or she generated on each of the questions, providing supporting rationale for why a particular technique was deemed appropriate or inappropriate in their memory tools compilation.

Field data was gathered by use of taped conversations and as written field notes. The extensive compilation of informant answers and elaborations to the questions was condensed by category and specific topic. Individual discussions were reviewed for information that appeared particularly pertinent to investigating each of the topics identified in the questions as fundamental areas of interest for this study.

## CHAPTER 4

## FINDINGS

Data was gathered from multiple sources. First, an initial student questionnaire was filled out before the training began to document any prior training and the individual's self-awareness of their memory skills. Second, the SKILLS instrument was completed to provide basic input on the use of memory components of metamemory. Third, a series of pre-tests and post-tests were administered to provide numerical indications of increased or decreased abilities. Fourth, the Kolb's Learning Style Inventory was given to each student to determine of their particular Learning Style. Finally, each individual was interviewed to determine the basic effectiveness and usefulness of the training sessions.

Preliminary Student Questionnaire

The initial determination of memory skills came in two forms. The primary questionnaire filled out during enrollment, gathered basic data (see Appendix 1), including: a) name; b) address; c) phone; d) age; e) current occupation (besides being a student); and f) major in school (if applicable). The questionnaire also asked several specific questions, including:

- a. How many years of education have you had?
- b. How many hours per day do you spend reading now?

- c. Have you had any prior memory instruction or training?
- d. How would you rate your memory currently?
- e. What are your reasons for taking the workshop training?

The basic data is presented in Table 2.

Each of these questions were used to investigate how the student viewed his or her memory ability at the start of the training. For example, there appeared to be no particular interdependence between amount of education and memory ability as viewed by the participant, since only four students placed themselves in the "excellent" or "good" stages. In fact, just the opposite occurred. Those individuals with the most education as noted by the researcher when reviewing the questionnaires consistently rated their current memory skills as "needs work" or "non-existent". One of the professors responded, "If I could get my stupid brain to work properly with all this material I need to memorize, I wouldn't feel the need to take this course." A student was equally specific: "Part of the time, especially when I'm studying, my brain acts like its a million miles away. How can I learn anything quickly when my mind has twenty things racing through it at once?"

The assumption that students who spend more time reading each day have developed stronger skills also proved false. The reading range, from 0.5 hours/day up to eight hours/day, didn't associate meaningfully with any memory ability, particularly since none of the students self-rated their memory ability as "excellent", and only four self-ranked their ability as "good". One of the students who self-ranked as "good" did feel that: "The more I read, the better I get at organizing things. But I have to re-read the

Table 2. Initial study participants data.

Characteristic	Number of participants	% of totals
Years of education:		
12-16	33	82.5%
17+	7	17.5%
number of hours reading/day		
0.5-1	6	15.0%
2-4	21	52.5%
5-7	5	12.5%
8+	8	20.0%
Prior training:	0	0%
Current memory status:		
excellent	0	0%
good	4	10.0%
fair	19	47.5%
needs work	4	10.0%
non-existent	13	32.5%

material at least twice before I feel comfortable that I know it (well enough to take an exam).” . One of the professors, who self-ranked himself as “needs work”, said, “Reading doesn’t make my memory stronger. It just gets harder every year to put all the required stuff in my brain that I need for teaching. Sometimes I feel that the time I spend reading is just wasted, especially when I have other problems to attend to that have to take priority.”

The only constant attribute shared by the entire group was that none of the students had any previous memory training. When questioned during the first training session, it became quickly clear that no one had ever taught any of them how to memorize materials. With a single exception (a student from Korea), all participants had gone through some version of the American public education system. At no point in their public school education had anyone explained how to learn or to memorize information.

As one student stated it

They (the teachers) just said go home and learn it for the test tomorrow. Never gave any idea how, or what really to learn, just enough to get a good grade on the test. Unfortunately, college is in a lot of respects just like that. No one tells you how to learn, they just say do it or you flunk! Tends to make my college experiences somewhat of a nightmare, especially since my basic way to study is to read over and over and hope enough gets locked in my head to pass the exam. If I’m lucky, I’m right.

(Mathematics student)

It is clear that memory training is not part of the normal curriculum in public schools, nor is there any instruction in learning techniques that would facilitate learning by students at any age level.

### Memory Ability Assessment

The second source of data came from the students completion of the SKILLS instrument (see Appendix 2). The mechanism of the instrument was explained in detail, since it was considered important for the students to understand there were no right or wrong strategies, only tendencies to use a particular strategy versus another. They were informed that everyone has their own approach to learning that works for them, and that no one method was particularly more valuable than another. Since this study only dealt with the section on Memory, scores were only tabulated for questions dealing with the Memory content. On the SKILLS scenarios, these were questions #9 (Organization), #11 (External Aids), and #13 (Memory Application). Possible scores for the general category range from 12-36, and the individual component scores within the Memory category range from 4-12, with a higher score indicating a stronger use of that strategy. Table 3 shows the scores obtained by the participants in the study.

It was clear that the majority of the participants fell in the range of either low or medium memory usage (range 16-25), with only two falling in the high memory usage range. Of more interest was the use of the three components involved. By examining Table 3, it should be noted that few of the participants did not attempt to use some sort of organizational strategy on a regular basis. However, when the class was asked during the initial session, the answers on organization indicated the students did not necessarily do anything consciously. For example, typical responses were:

Table 3. SKILLS scores for participants.

Category/Component	Score	Number of individuals	% total
Memory	16-30	40	100%
sub-ranges:	16-22	22	55.0%
	23-25	8	20.0%
	26-30	8	20.0%
	29-30	2	5.0%
Components	4-12	40	100%
organization:	4-6	4	10.0%
	7-9	18	45.0%
	10-12	18	45.0%
external aids:	4-6	15	37.5%
	7-9	15	37.5%
	10-12	10	25.0%
applications:	4-6	20	50.0%
	7-9	18	45.0%
	10-12	2	5.0%

I just hope and pray it goes into my brain, at least long enough to pass the test. If organization means tying it all together while I'm reading, I'm sure I don't do that. My basic way to study is find the key words, the ones I think the author (and probably my instructor) thinks are important, and try to be sure I have them clear enough in my head so I can get at them when I need to.

(Paralegal student A)

I do all the right things. I underline, then I highlight in bright yellow, then if I have time I outline the chapters. If that's organization, then I do it - so how come I keep getting 'C's on my stupid tests?

(Criminal Justice student A)

None thought they deliberately or consciously organized materials in their memory, nor did anyone feel such organization was a determining factor in their ability to memorize materials.

In terms of the use of External Aids, there was a wide range of student ideas for use. Almost 40% of the class rarely used such means for assistance. The remainder used them extensively. Typical comments were:

I wouldn't dream of going grocery shopping without a list. Otherwise, I'd end up going to the store four or five times a week to get the stuff I forgot.

(Accounting student)

My basic way of studying is to outline whatever I am reading. If I don't outline, I might as well be reading a novel for all the good it does me in remembering anything. Same thing applies for phone numbers or addresses. If I don't write them down, they're gone faster than I can say them.

(Chemistry student)

I never use memory aids. I figure if my brain doesn't want to cooperate with me, I'll get more out of it if I force it to cooperate. Writing things down just gives my muscle, it will get better and stop forgetting. All except numbers, anyway. I couldn't remember a telephone number long enough to dial it on the telephone (thank god for re-dial on the phone machine.

(History student A)

In terms of Application of memory to solving problems, foreseeing the future, or being prepared for eventualities, the large majority of the students (over 90%) did not seem to even address the issue of looking at or working with their memories. Most often the application of memory to problems was taken for granted:

I have a problem, I'll solve it, one way or another. If it's like one yesterday, I guess I use what I learned then, but then again I might do it a totally different way. What's memory got to do with solving problems anyway?

(Undeclared student in military)

When I meditate, I do best when I'm reviewing my own experiences, my remembering of what I enjoyed in the past. But if I see a problem coming in the future, I don't particularly try to use what I remember to solve it ahead of time. I wait till the problem gets here. Why waste time trying to solve it before you know all about it? (And, yes, I do stress out a lot over problems, especially ones it looks like I can't do anything about initially, especially money).

(Biology student A)

Specifically students take their memory for granted. They tend to accept it as it is even when improvement is obviously needed. Since, however, they have no means or ideas on how to improve their memory ability or skills, they tend to work around the issue by doing whatever is necessary to augment their learning to the level they feel they are capable.

Learning Style Assessment

The Kolb Learning-Style Inventory questionnaire categorizes the students into the four learning styles identified by Kolb (1981). The resultant determinations are displayed in Table 4.

Table 4. Learning style categories and participant

Learning Style	Number of Participants	% totals	*Memory Ability
Converger	4	10.0%	4
Diverger	9	22.5%	7
Assimilator	12	30.0%	8
Accommodator	15	37.5%	11

\* Memory Ability refers to scores on the SKILLS instrument, where low scores ranged from 16-22, medium from 23-24, and high scores from 25-30. Memory Ability totals are those individuals that ranked in the low score range.

The general conclusion from the data is that there is no particular relationship between learning style and memory ability. Of the Convergers, three were in the low score range for Memory (16-22), with only one in the high range (26). Of the Divergers, seven were in the low range (19-22), while two were in the high range (26-27). For the

Assimilators, eight were in the low range (16-22), but four were in the high range (26-30), including the highest scores on the instrument. Lastly, for the Accommodators, eleven were in the low range (16-22), with four in the high range (25-29). No particular association stands out between the Kolb Learning-Style categories and the use of Memory as shown by the SKILLS instrument.

#### Pre-test and Post-test Scores

Pre-tests and post-tests were administered on the first and last days of the training sessions (see Appendix 3 for sample tests). The total time between tests was four weeks. The results are tabulated in Table 5. There were eight separate tests given. The t-tests compare means of the pre/post scores for eight tests. Each t-value in the last column resulted from a comparison of the two mean scores for the pre- and post-tests. Since the same subjects were used to obtain the means compared by each t-test, the researcher used a correlated samples t-test. As noted by the asterisks and the footnote beneath the table, there were significant differences found between the pre and post means for the group. The table indicates that training in all phases caused subjects to receive higher scores. Individual data sets showed greatest improvements in the ability to remember Lists, Ordered Objects, and Names & Faces. Less successful techniques were the ones dealing with numerical data, particularly Telephone Numbers and Long-Digit Numbers. Much

less trouble was had with learning how to memorize Dates in reference to particular events.

Table 5. t-Tests for Pre and Post Memory Scores of Participants

Exam Type	M	SD	t
1. Words (20)	7.5	3.63	13.16*
2. Ordered Words (20)	8.48	4.17	12.87*
3. Number list (15)	4.62	6.23	4.69*
4. Names & Faces (10)	3.18	1.92	10.49*
5. Phone Numbers (10)	0.6	1.13	3.37*
6. Dates (10)	2.05	1.87	6.93*
7. Paragraphs	4.60	4.69	6.20*
8. Essay	2.03	11.93	6.66*

\*  $p < .01$

#### Interviewing and Observation Results

The interviewing and observational process yielded some fascinating results in regard to the motivation, developed abilities, and self-evaluation for the students in this

study. In many respects, there seems to be no over-all pattern to the value of the memory training techniques. Nor does there seem to be any clear relationship between Learning-Style and ability to develop memory skills from such a training program. However, there were patterns evident when dealing with particular techniques that were developed, and patterns evident in the question responses.

### Memorization Topics

Perceptions. The individual estimation of the successfulness of any training program, be it mental or manual, revolves around the expectations that are often carried into the program. As observed by the researcher in his own university classes, when individuals have negative expectations, programs are often ranked low in value: this is often evident with students evaluating college classes after they have failed the class. Conversely, individuals with positive expectations often rank classes highly because of their belief the class will be good no matter what.

The overall impression of the participants in the memory training was that it was a definite success. It provided a variety of tools that individuals could use in situations where memorization was essential. Typical comments include:

If I had had this four years ago, college would never have been as much trouble as it was. This is something I think they should teach kids starting about the third grade!

(Undeclared student B)

I can't say I learned all of this, but I certainly picked up a lot that will help me in my business. Just the game of putting Names on Faces has already helped me with my customers. And making pictures, then adding to them, lets me play games with them that gets them amazed how much I remember about their lives and families. Just knowing about their kids, their pets, maybe their last vacation, makes them think I really pay attention to them, and it's showed in the increase in my business.

(Businessman, undeclared student)

Success rate 100%. I've never found it so easy to memorize materials. Even one of my profs is amazed, since I don't take notes in his class anymore (I think it drives him crazy for me to sit there watching him while everyone else is writing frantically). My grades are going up - for the first time, I think I have a good chance to get an 'A' average for a semester. I'd recommend this to anyone going to school here.

(Nursing student B)

The conclusion expressed in the second comment, by a student who is also a professional businessman, seems to be the consensus of the students. For example, 90% (36 of 40) of the participants felt that much of what was done would benefit them in the future. All agreed that more time spent would be of great value in learning the systems better, and that a workshop of more than four weeks should be established.

However, before accepting the success of the training, it should be noted that there was a small (four students) group that felt the training was not successful. Reasons for this differed greatly:

There was too much stress to perform here, almost as much as in my nursing classes. Much of what you taught was lost, either because it didn't help me with my studies, or because I thought it was too hard to use.

(Undeclared student C)

I can understand why you need to start with the simple things first. But I'm not interested in about half of what you did, like the foreign language vocabulary, or the law statues, or historical dates. I'd like a course directed more towards what I need to learn in respiratory therapy, not memorizing mathematical formulae or chemical reactions. Drop about half the material and it would be a good course.

(Respiratory Therapy student A)

The most negative comments came from one of the education majors. She felt the course was entirely too difficult:

With the class load I have already, I expected this workshop to be something simple, something I could use immediately in my studies. Instead, I found what I really wanted only showed up near the end of the course - all the rest of it was, for me, wasted time, since I could give a fig about lists or word orders, or faces. I'm not interested in learning foreign languages, so that material was all bogus for me. But the biggest problem as I saw it was the class participation you required. I don't like talking in front of other students, especially when every time I talked it was a test of my recall ability. If my recall was great to start, I wouldn't have wasted time taking the class! My Ed instructors all agree that memory has no place in teaching the elementary grades; students have to be taught how to learn, not to memorize like parrots. You should concentrate on developing learning skills, not simply putting stuff in your head so you can play Jeopardy or be a walking encyclopedia. I think memory ability is vastly over-rated, and this course hasn't done much to improve mine. I certainly didn't gain anything I will use teaching fourth graders!

(Elementary education student A)

Obviously the course isn't suitable for all students. The criticism that memory skills are not important seems rather harsh, especially since it is well recognized that unless material is located in the brain in the form of a memory trace it is virtually useless for doing any sort of original work (Buzon, 1989). That is to say, unless a student has

had access to the material, and in one form or another committed it to memory, the student has no means of knowing if the data is relevant to his or her current problems or not. It appears to limit the influence of memory skills when instructors of adult learners profess that memory skills aren't needed, but should be replaced with learning skills only.. One of the essential learning skills is memory ability, particularly in the form of metamemory. This does help clarify, perhaps, if this attitude is so prevalent, why none of the participants had ever been taught in their pre-collegiate years how to memorize materials.

Memory Technique Factors. There are a number of factors that play a role in the viability of any learning techniques. Such attributes include factors such as usability, difficulty of acquiring the skill, amount of repetition available for reinforcement of the skill, time constraints, the presence or absence of peers, peer pressures, and the presence or absence of a constructive environment. To what extent these factors interact and which dominate in learning adventures has not been clearly established.

The perceived usefulness of the various memory techniques discussed in the training varied, as would be expected, in accordance with the needs of the participant. One of the nursing students, who had previously struggled to learn the copious amounts of material for her classes stated, "Everything helped tremendously. I especially use the Storyline technique, since I have a lot of list-type items to memorize, such as the fourteen steps to restrain a person in bed." Another nursing student preferred the Faces & Names

technique, since, "Nothing makes patients feel better than calling them by name right after you've first worked with them. I also appreciated the English vocabulary session with the Picturization technique, because learning nursing is like learning a brand new vocabulary. Now it's easy."

The entire range of techniques was included by students from various disciplines as the methods liked and used most. From Paralegal studies, one student said, "I really found the Number Alphabet System" (making use of pre-memorized pictures for numbers) the best. It made memorizing law case statutes about a million times easier." A student in computer sciences agreed, reiterating, "The Number Alphabet System helps me tremendously. With all the historical dates I have to learn for my American History class, putting them into pictures and linking them to the actual events or people is now a piece of cake!"

A different perspective was expressed by virtually all the science students. Depending on whether it was chemistry - "I found the use of the Letter Alphabet System the most useful, since I have formulae and chemical reaction equations to memorize in organic chemistry" -- or biology -- "The process of Picturization and Storyline were the most helpful in my Molecular Biology class for locating and describing parts of the cell" - the techniques most stressed were near each other in the process of training but were ultimately different. The mathematics student preferred a combination of the Number Alphabet System and the Letter Alphabet System: "Turning mathematical symbols and equations into pictures takes time, but I now learn the material a whole lot better than

before, and it stays with me for about forever. Helps in solving problems, also, since now I don't have to keep referring to the book to review."

Each technique used in the workshop was stressed by at least one student as the most important, with the rationale being that it was the most useful for their particular area of study. Even the students expressing the belief that the class was unsuccessful each found a technique that was beneficial to them. All four of those students were most satisfied with the first two techniques taught, the Picturization System and the Storyline System. The education student stated, "The use of pegwords for educational concepts is particularly helpful in my studies." One of the respiratory therapy students felt that: "Knowing how to link material together to access the steps in therapy is quite a time-saver."

Several students preferred the alternative methods for memorizing lists of material, including the Rhyming Method, the Storyline Method, the Shapely-Figures Method, and the Homeroom Mapping Method. A sociology student stated, "Putting things on my front-room furniture is a clever way to make them accessible to me. I know those decorations inside and out, so hanging pictures on them is easy." Another student in the military found it convenient with her children: "The kids love the Rhyming Method. We make a game of it - I make the lists, and they do the pictures using the rhymes that cover the numbers. I didn't believe five-year olds could learn so fast."

One of the professors found that all those techniques helped.

If I have more than one set of items to commit to memory, it gets confusing if I keep using the same picture-story process. When I vary it using the other list

procedures, I can do all of them at once without having them becoming intertwined or mixed up, something important when I'm lecturing since I don't want to be talking about business when I'm handling accounting. The only unfortunate problem is that most of them are limited to ten items for me to talk about if I'm using the rhymes or shapes. But I'm getting much better using the Homeroom Method, especially since I expanded it to include the other rooms of the house.

(Professor A)

A final comment should be added regarding successful techniques. One of the general science students said she liked all the methods, but found, "The last ones, with the Mental Maps and Recall Patterns, were tough to do because they required so much effort. Better to stick to the simple ones." Three students enjoyed the challenge of learning each of the techniques and were going to keep with it till they had each one mastered. As one professor said, "I can't do it (the Mental Mapping) yet, but I see its value for both instructional purposes and learning. So not only will I get it, but I'm going to try to instill it into each of my students this coming semester."

All the techniques are appropriate for teaching to a set of students with divergent abilities and interests, and of differing ages. It needs to be emphasized that simpler modes need to be introduced first. These earlier techniques must be fully comprehended and implemented before proceeding to advanced methods. Otherwise, the students will balk at dealing with concepts that are inherently difficult, more time-consuming, and require more mental dexterity to use.

Implementation Difficulties. With every training program, there will be problems that are left unresolved prior to the beginning of class. This happens because it

is unlikely that every possible contingency will be anticipated. The memory training sessions were experimental in nature, being modified in content as the course proceeded: that is, the techniques used to present the material and demonstrate the procedures were augmented or changed as it was perceived necessary by the instructor to handle student problems, such as inability to concentrate, difficulties with making ridiculous pictures, and problems with linking pictures together into stories. A workbook was developed for future use in the class, and was offered to the students at the end of the training program as both a refresher on the memory techniques and a tool for future explorations on their own.

Without a single dissent, all the participants found the last two procedures, the use of Recall Patterns and Mental Maps, the most difficult to implement. Some of the students refused to even try them. A student in criminal justice was blunt: "They are too difficult for me to ever see a use for. I'll stick to the others that I know I can do successfully." Another student in the same major found them confusing: "I spend so much time making the map that I lose track of where I am." And a science student said, "They don't allow me to get down to the bare-bones of details I need to process for chemistry tests."

However, even with that difficulty, most saw the advantages of the two techniques. A computer science student summed the view nicely:

They involve a lot of hard work, I can see that coming. But the usefulness is without a doubt. I think the use of Recall Patterns would make any subject easier and more comprehensible. I especially liked the method you taught us associating that with how to read through a chapter in a book. By breaking it (the reading)

down into digestible parts, it makes more sense. Going over the pictures, graphs, bold face type, and all the rest of the non-textual materials first gives a good overview of the chapter. Following that by reading after removing all the distractions allows me to concentrate better on what is being written without continually disrupting my concentration by focusing on pictures or other things not germane to what I'm currently reading about. I think once I master this technique, all the rest won't be necessary. And I've come to realize the Mental Maps are just another way to do the recall. But I like the circular pattern better than the mapping, so I'm going to concentrate on developing that one for use.

Some of the other techniques were mentioned by name as particularly troublesome. Students complained about the amount of initial work effort necessary to develop the Number Alphabet System. A biology student stated, "That's about as much work as memorizing (human) anatomy lessons. But I can see the value." Several, such as a paralegal student, learned the system, but don't plan on using it. "I did it because you wanted us to, but its easier for me to write numbers down that try to remember them that way." Likewise, a student related the following:

When I tried to use it for class, my pictures got all jumbled up together and I couldn't separate them from ones I used the day before. I still know the Amendments to the Constitution perfectly, but when I go to apply it to my own subject, I have a lot of trouble making meaningful pictures to associate with the numbers. I think I'll stay with the story picture procedure and write down numbers. I don't consider that a failure, because I never was good at remembering numbers anyway.

(History student A)

The most difficult procedure for the majority of students actually came about during the first technique, that of Picturization. The problem rested on the insistence by the researcher/instructor of making pictures that were ridiculous, exaggerated, colorized,

and mobile. Many students had trouble making ridiculous pictures. One of the student-housewives stated, "I can't make my pictures crazy at all. I'm too practical - I have three kids to take care of, so there isn't much time for day-dreaming. And I can see where normal pictures won't work." The professional in speech pathology added to that: "It goes against my nature to make pictures that aren't ordinary. It takes a lot of effort to make ridiculous ones, but I am getting better with practice." Finally, a nursing student maintained, "My pictures take too long to make if I form ridiculous ones. I'll settle for common things, then just jazz them up a little."

By far the most common complaint was the inability to rapidly make ridiculous pictures. However, by the end of the second session, everyone had perceived the value of making pictures out of the ordinary even if it took longer because of lapses that occurred in memory when trying to recall materials gone over an hour before. Several students relating their experiences emphasized that, with ridiculous, gory, or laughable pictures, materials seemed more locked into the brain and easily retrievable. Such testimonials helped stimulate the entire class in attempting to form stronger mental constructs. A single example suffices:

Historical events tend to run together, but not if I make pictures that involve lots of blood, gore, and mayhem. It doesn't matter what the events are, I can turn them into a mess of connected pictures that really stand out. I don't use ones that make me giggle much, but I sure can form ones with violence and lots of fighting that stick with me. I did this in my history class yesterday. I turned everything he said into a picture emphasizing fighting and some sex. Didn't take a note for the entire hour. When I got back to the Villa (the University's housing), I compared what I had with my room mate's notes - and I remembered much more than he wrote down! The trick is to learn to do it fast, and that comes with practice. I make ridiculous pictures now when I'm on the phone, listening to the

news on television, talking to friends, even just walking to and from campus. They aren't all violent, but, man, it sure helps.

(Sociology student)

It is clear that more time needs to be spent on the process of rapidly formulating pictures that are unusual and perhaps not ridiculous.

Usability of Techniques. Although many of the memory techniques explored in the workshop have been utilized for generations, most have not been taught in any coherent fashion in formal educational settings (i.e. in classrooms). Various researchers (Kail, 1990; Howe, 1992; Wyer, 1989) have had some success with several of the techniques, including formulating pictures, and dealing with names and faces, none have tried educating the participants first in an extensive, intensive fashion over a wide range of techniques. Each of the modes of applying memory skills was presented independently of the others with the sole exception of the Picturization technique, which was fundamental to all the subsequent techniques.

Students were in agreement as to why certain techniques were comparatively easy to apply while other techniques were non-useable. The basic reason could be summarized succinctly as: I'll learn only what I need to get the problem or job done. Eighteen of the students felt that there was no particular reason to learn how to implement all the techniques since many weren't going to be used again anyway. As the math student responded, "I deal mostly with numbers, so that's the system I focused best on. Why bother with most of the others when I can see how to adapt the number alphabet to

just about everything." A science student exclaimed, "When I need to remember something, I can use pictures linked together for all situations, so forget about doing the hard stuff." An education student explained: "The ones I like, I use. The rest were interesting to learn, but they involve too much effort while the others don't. And I have too much work to do to waste time on methods I won't use."

It is notable that this agrees with the idea that researchers such as Verner (1964) have found in adult education:

The motives that lead to participation in adult education or to learning stem from the needs that arise out of experience. The nature, quality, and intensity of motivation is influenced by such factors as knowledge of the task, level of aspiration, previous experience, social role, and perception of education. ( p. 22)

Other researchers have emphasized the role of individual expectations and requirements in the learning process:

It must be realized that an individual's expectations are powerful determiners of both his behavior and the behavior of those he influences. A possible message for those involved in adult learning is that expectancies should, at the very least, be realistically based and, in appropriate circumstances, biased to favor a desirable outcome... what one expects of the "old dog" confronts with a "new trick" may be as important as the technique one uses for teaching him the trick." (Griffith, 1970, p. 57)

The outcome of this training session seems to adequately support those viewpoints.

The techniques used were most often related to the particular degree field the student was involved in. All the science and math majors preferred the Letter Alphabet System along with the Picturation System, since both were most appropriate to their learning requirements. The businessman and all the members of the military and the

police department used extensively the Faces-&-Names System for work. The professors preferred the Picturization because it made their lectures easier to prepare and deliver. As one stated, "I can talk without use of notes if I make my pictures strong enough. And it's easy to break off onto side-tangents for fun topics, because I can always find my way back immediately to the last picture-topic I was talking about."

Sixteen of the students were interested in learning the entire scope of methods presented. The goal in each case was to get as much as possible from the training. "I don't know what I need or want until I see it, so I need to see everything," said the criminal justice student. Another in the same field responded, "If it reduces my work load, I want to learn about it. And all this means less time spent studying, so I want to be able to handle it efficiently and concisely." One final comment from a biology student: "I plan on med. school, so whatever I can learn to do efficiently now will only pay dividends in that hectic environment. Actually, every technique you covered I've tried in my medical books, and they all work, some better than others. But when I got that 'A' in Human Anatomy without killing myself nightly like I did the first semester, you had me convinced forever of the importance of learning these techniques."

In general, the techniques not felt usable fell into two categories: (1) techniques that were too difficult, such as Recall Patterns and Mental Maps; and (2) techniques not felt important for a student's particular area of study. Category 1 items, as mentioned above, were simply too difficult for most of the students to want to get involved with, although most did try to implement them and several students were actually quite

successful with them after extensive practice. Category 2 items, such as learning foreign languages or chemical formulae, involved techniques that for one reason or another were felt not to be relevant to the participant. Each individual learner had his or her own particular motivation for mastering or avoiding a strategy. Most reasons revolved around what was important for the currently existing requirements of school. "I don't want to waste time on methods that won't help me remember my lessons. Reading and learning take up too much time as it is now without trying to learn questionable techniques (just ask my husband about time I'm wasting)."

The latter statement above succinctly provides one of the more important characteristics of an adult learner: usability of the material being learned. This is in strong agreement with Snow (1955):

Another characteristic of adult learners is that they may have their attention firmly fixed on a goal not of learning itself but rather of tangible achievement which may result from the activity... Basically this attitude of absorption in the goal can be a great advantage in the learning situation, serving to motivate the student and define the learning task. It constitutes an advantage over the goal-less activity in many formal academic programs where activities are pursued solely to satisfy a scholastic requirement. (p. 73)

In two instances, other reasons were expressed. "Some of the techniques are boring. I do great with pictures, so why change," one education student exclaimed. The physical education student agreed: "Maybe it's the material, but some of the techniques are boring, and some of them just make me feel stupid. You said a fourth-grader could do them, but I have trouble with them, so I guess I'd better stick with the ones I can do."

In addition to boring, at least one student found the techniques too much busy-work:

“When I’m reading, I don’t want to slow down to make pictures. When I have two hundred pages to read for the week, making pictures makes the project a whole lot longer. Get some simpler techniques and I might reconsider.”

Reasons why techniques worked best and others failed to be useful are varied in the extreme. But one major element stands out: only when material is made relevant to the wants and needs of the learner will the individual even consider putting forth the effort necessary to make the technique part of their own repertoire of skills.

Memory Improvement Benefits. If the value of memory training only was appropriate to the workshop duration itself, such training would be worthless in the larger perspective of education. The goal was to be able to instill the methods for memorization so that students would be able to access them as needed, modify the various modes into forms usable in the student’s own situations, and allow for future development of enhanced skills. The use of those memory skills was to be both in educational endeavors, such as the university or college classrooms, and in the outside world, such as in business or personal situations.

Perhaps the largest advantage outside the training session came with the application of the newly acquired skills to either regular school situations or business dealings. With two exceptions, the participants found the material carried over in one form or another to daily life. In those two cases, neither student felt the techniques were

useable in school situations nor in preparing for class work. "My memory's good enough without all this fiddle-faddle making pictures," and "I don't need that hassle on top of everything else" were typical comments.

However, for everyone else, benefits were multitudinous. Many students reported increased grades in classes due to their new skills in memorization. "I've went from being a solid 'C' student to getting four 'A's and one 'B' because now I know how to learn faster," one biology student exclaimed. "Not only did my grades improve, but I had more time for my wife and kids, and that's worth any price," a paralegal student said. "If I had known how to do this earlier, my first three years would have been a lot less stressful," boasted a chemistry student. One last student comment summarized student positions nicely:

Learning's faster, book work easier, lectures clearer and more interesting. I enjoy reading again because it takes less time and effort since I don't have to read things ten times over to get them to stick. I found the neatest side-benefit from this: even when I don't make pictures, my brain seems to gobble the material up and organize it better for me now, as if its doing it even when I'm not consciously forming pictures. My grades aren't up (she is a straight 'A' student), but life at school is much easier. It's fun to give my teachers (only the ones I enjoy and can talk comfortably with without feeling there will be any negative feedback later) shots on what they said before and then contradicted - makes for some nice discussions and makes the classes more enjoyable. And we're (her and her husband) teaching it to our kids, who love it. Now if we could just find a school that appreciates smart kids and tries to encourage their brightness instead of stifling them.

(Accounting student A)

Outside the school environment, the training has played several roles. The businessman explained, "All my customers think its neat I know so much about them."

The secretary maintained, "Communication with total strangers has become a lot easier, since the first thing I do is learn their names and something about them. The next time they come back, I've got that at my tongue tip, and it impresses the heck out of them."

One of the military personnel used it for advancement: "Those tech training manuals we're required to memorize weren't easy, but I finished them way before any of my friends. That allowed me to jump a grade about half-a-year earlier than I had planned."

A final comment from the police officer summarizes uses nicely:

Names-&-Faces was made to order for dealing with people I know so many more people's names now, can say hello and get treated nicely. Plus I have a great memory for names and faces of people with outstanding warrants. Preparation for advancement exams is straight forward, where before I had a lot of stress. I am much more aware of the environment around me now, more cognizant of the people and what events are transpiring. Helps keep me on my toes without my whole body becoming tense continually. Between finishing my degree (in criminal justice) and moving up in rank, I'd say it was a most successful year, a lot of which was due to the memory training.

(Criminal Justice student B)

The process of training memory to be used in external situations got mixed reviews, but only two were negative, feeling the training was unnecessary or inappropriate. The remainder, however, were positive in nature, stressing the benefits of memory skills and advancements made in their present situations from their ability to learn the newly learned techniques.

Nature of Instruction. One of the variables in the use of a memory workshop is that of the instruction provided. This is dependent on two major factors: (a) the nature of the material itself in terms of difficulty; and (b) the ability of the instructor to deliver

the information in a coherent and easily-understandable fashion. A substantial amount of preparation was required to formulate the topics, order of presentation, specific discussions and demonstrations, and packaging of hand-outs that were to make up the workshop. The goal was to continuously make the materials not only learn-able but enjoyable for the students.

None of the respondents found the memory techniques instruction as particularly confusing or hindering in the approach to their studies. The two students who felt the entire course was not appropriate for them had no trouble understanding the material: they simply didn't find it useful for their particular needs. "Your presentation was, I should say, often inspired, to be fair to you. But the techniques just wouldn't stick," one stated. "I like your style, what I'd call a performance piece, but the material wasn't important to me," exclaimed the education student.

The remainder of the students concurred with each other. "Delightful job of presenting the ideas," a biology major explained. "You made it fun and enjoyable. I remember your pictures best of all," another biology student exclaimed. One of the professors stated:

There weren't any problems I could see in presentation. That was about as straight forward and non-confusing as I've ever seen a class done. The use of overheads to help focus attention on the topic give me room to maneuver (in my brain) because I didn't have to worry about getting lost if I wasn't always listening directly to you. Ease of use is important to me, and you made most of the topics easy to see and do. Those people who didn't get it were just grouchers anyway, didn't want to try. I'd give it an 'A' for effort and content.

(Professor B)

Training Process Review. A final review of the structure of the workshop is necessary to determine clearly what succeeded with the participants and what would need to be replaced or discarded in subsequent workshop offerings. As a result of the interviewing technique and feedback, problems were quickly brought into focus.

Participants identified two aspects to the training that arose from the instructions: what was liked, and what was considered intimidating. The pattern developed that students liked the variety of techniques used and the demonstrations assisting with the development of individual skills. In addition, the use of experiential testing immediately after demonstrations of the techniques was considered a substantial advantage in reinforcing learning.

I could see myself doing it immediately, which was a tremendous advantage. After the first picture quiz with the twenty words, I thought I'd fail badly. You'll never know what it did to my confidence when you called on me first in that initial exercise and I got all twenty words right! And when the class applauded - well, that Sunday was fabulous!

(Science student A)

Your demos were a lot clearer than just watching words projected on the screen. I'm a 'hands-on' person, so when it got down to us doing it, I felt more at home and at ease. I thought when I did the Letter Alphabet right I'd just burst - that's about all my husband heard about at dinner.

(Undeclared student C)

The fact that you took so much time with me myself did a lot for my confidence. Most teachers don't have time for stupid questions, but you didn't see them as stupid (I was sorry I was the one that asked that one question for the fourth time). Individual attention made this class more meaningful for me. With all the laughing and carrying-on, I didn't have any stress or fears (at least that I was aware of) after the first thirty minutes.

(Undeclared student D)

The only trouble consistently mentioned for the workshop involved the time factor. Virtually everyone agreed (38 of 40 participants), with the exception of the two students who thought it unsuitable for their needs, that four weeks was not a long enough time to assimilate all the material presented. Several also thought that spacing the classes a week apart was too long a period to go without review. While most participants were basically satisfied with the individual session length itself, several complained that "three hours tended to cause headaches from thinking so hard." In terms of time, a major theme was expanding the workshop total duration:

I'd be willing to go eight or more weeks if you had more examples to use for each of the techniques. I'd like to see another demonstration on each one so I can be sure I've grasped all the essentials.

(Paralegal student B)

Four weeks cramps too much in together. Don't drop anything, or maybe the material on recall and maps, but spread it out more. That would give me a better chance to get good at the ideas you gave for that week without getting them jumbled with those from the next one.

(Criminal Justice student C)

However, one of the professors argued against spreading the material out over a longer duration:

I know from past experience that if you spread it over a longer time, you'll just lose students. It's difficult enough to maintain interest over four weeks without having to commit yourself to six, eight, ten, or some larger number - that's my main concern with semester-long classes now, where we have a tremendous amount of material to cram down the student's throat in the name of education. If you spread it out, you'll lose students, so they won't see the later techniques anyway. If you have to do something, drop the last two topics and concentrate on the easier ones to implement.

(Professor A)

It was suggested by several students that the need for longer duration of the workshop times might be handled by meeting more than just once a week. Several students advocated meeting like a regular class, on a two or three times-a-week basis. "Our other classes do that, so why couldn't you?" one nursing student asked. "Three times a week wouldn't be any more imposition than meeting on Sunday (my only day off)," exclaimed a respiratory therapy student. When questioned in class, the large majority (>80%) felt that moving to a two or three times-a-week training session would be more beneficial. However, one student, in counseling, argued against it:

These techniques need practice if I want to make them my own. If you go to three times a week for classes, I won't have enough practice time between classes to fill comfortable with them. Plus then they conflict with my regular classes. Were that the case, I probably wouldn't take the workshop in the first place.

(Counseling student A)

Likewise, one of the professionals argued against changing the training schedule:

Just meeting on Sunday for four weeks is okay, but more than that I couldn't handle. Trying to balance a business, school, kids, a wife who wants her share of my time, my own gym activities, going out with the guys - I'd probably never even try to take this if it met a couple times a week. I know I'd never get the time to practice, despite what you said about doing it in the bath tub.

(Business major A)

Simplifying time constraints on all three levels -- three hour meetings, meeting once a week, and meeting for four consecutive weeks -- seems like an intractable problem due to the nature of the individuals involved, each with their own schedules and life styles. It is agreed that allotting more time for digestion of materials, repeated

demonstrations, and rehearsals will facilitate the learning process. The optimum time allotment, at any of the three levels, is however highly questionable.

Advantages to Memory Training. One of the key determinations of the successfulness of the memory training was to revolve around the perceived advantages to the students. Prior to the implement of the study, there were a number of possible advantages considered, such as increased learning and comprehension, and increased concentration ability. However, a much wider variety of advantages became apparent both during and at the end of the training sessions.

There were a large number of advantages individuals found from the training units. The advantages noted are listed in Table 5.

The major benefits revolved around several items. The first was additional free time gained by not having to re-read materials to commit them to memory. For example, the computer science student said, "Takes me about an hour to do what I used to get done in around four. More time for my kids." His sentiments were echoed by a nursing student, who exclaimed, "I learn faster and better, enough to pass with good grades my nursing class exams. That's more time my husband is off my back about too much studying." One of the biology students was more pragmatic: "Ten hours are reduced to three, gives me more time to watch boys."

Table 6. Advantages Perceived to Memory Training

Perceived Advantage	Number Students	Percentage of Students
Better grades	26	65%
Taking tests	25	62.5%
Free time	22	55%
Dealing with others	18	45%
Increased concentration ability	16	40%
Increased comprehension	12	30%
Remembering names & faces	11	27.5%
Increasing joy of reading	8	20%
Seeing relations between parts	6	15%
Reducing fatigue during study	6	15%
Playing mind-games with kids	6	15%
Reducing need to take notes	6	15%
Eliminating external aids	6	15%
Removing stress from learning	6	15%
Expanding knowledge base	5	12.5%
Learning legal code verbatim	5	12.5%
More confidence	4	10%
Committing scientific materials	4	10%
Making money	4	10%
Learning new subjects	4	10%
Increasing vocabulary	3	7.5%
Doing poetry	3	7.5%
Preparing/delivering lectures	3	7.5%
Seeing objects more vividly	3	7.5%
Applying skills to problem solving	3	7.5%
Learning foreign languages	2	5.0%
Home-schooling opportunities	2	5.0%
Recalling scripts/materials verbatim	2	5.0%
Techniques for maps, details	2	5.0%
Using auditory stimuli	2	5.0%
Writing papers from memory	2	5.0%
Viewing the world differently	2	5.0%

Table 6 Continued

Winning knowledge quizzes	2	5.0%
Facilitating art work	2	5.0%
Drawing from memory	2	5.0%
Learning new habits	2	5.0%
Increasing manual dexterity	2	5.0%
Making complex materials simpler	2	5.0%
Writing computer programs	1	2.5%
Learning how to really think	1	2.5%
Recalling prior events	1	2.5%
Reducing life's complexities	1	2.5%
Developing chess strategies	1	2.5%
Developing story plots	1	2.5%

Development of free time was also related to better test taking abilities and receiving better grades. In fact, the premium of worth seemed to be the ability to increase grades for the large majority of the students. Typical comments were:

Tests better, grades better - my parents are ecstatic.

(Undeclared student D)

The stress of test-taking is greatly reduced thanks to one simple memory skill, that one using pictures for any concepts. I'm still not a great student, but I'm working on it.

(Paralegal student B)

Because I want to go to med. school, grades are of immense importance to me. Anything that will give me an edge in earning 'A's is worth the effort, especially if I can then use it in medical school also. I found part of what I need here.

(Biology student A)

Lastly, in terms of all three quantities mentioned, the computer science student stated it best:

I've free time for the family, for getting better with my computer, for learning more computer languages. Tests are a worry of the past. Now I know I can study the material once and not have to look at it again. I don't need to take notes, so class is more enjoyable. Too bad high school wasn't like this.

(Computer science student A)

Of the multiple advantages stated by respondents, the overlap is most often between people in the same fields of study. Two of the more fascinating ones refer to increased concentration and increased comprehension. A paralegal student explained, "I find I can concentrate anywhere now, just by making pictures. So much energy goes into the pictures that disturbances just don't seem to get across my brain." A counseling student mentioned, "Picture-making focuses so much on the mental picture that outside distractions can't reach me." And the secretary added, "I can't do that (make pictures) at work. Sometimes if I do, I miss what is going on around me. It's embarrassing when the boss or a client has to repeat something because I was off doing ridiculous day-dreaming."

This ability to concentrate more was noted by all the participants when asked during the training sessions. More than 90% responded that the memory drills had the same effect during home practice. By focusing on the formation of pictures, the ability of non-substantial distractions to pierce through to the conscious brain seems to be greatly reduced. Such single-mindedness of purpose may go a substantial amount in formulating

stronger memory traces, associating them more clearly with memories already stored in the long-term memory unit.

Comprehension was noted to increase by a large number of students. To make decent interactive pictures, students had to work harder at understanding what they were studying:

If I couldn't come to grips with the stuff, I couldn't make a picture. I knew I had it, grasped the essentials, when I could make a meaningful picture and then move it into contact with the next one.

(Counseling student A)

Didn't matter how abstract the concepts were, and in accounting some of them are really abstract. When I finally developed a great picture, full of colors and pieces moving all over, I knew I had that chapter cold. Once I stopped worrying about making pictures as fast as you (the instructor) could, and concentrated on doing my own versions, my ability to comprehend even 4x4 matrices in accounting were way overboard. Sex in the pictures works great, too, especially for really abstract topics. Also, my reading speed dropped because I was initially so slow. But it's now up to about 300 words per minute and climbing as my pictures come faster.

(History student A)

The variety of other reasons given are interesting in that often give clues to the personalities of the students involved. For example, the mathematics student has an inordinate fondness for chess and was a co-founder of the University of Great Falls Chess Club. The computer science student enjoys writing programs and playing complex interactive computer games. Great importance to learning the legal code was given by all the paralegal students and several of the criminal justice students. Interactions with clients or other personnel was ranked important by all the business people, all the military personnel, and the police officer. All three of the professors offered advantages relating

to free time, expanding the knowledge base, learning new subjects, and giving better lectures. The students who also identified themselves as housewives were more interested in advantages dealing with educating their children at home or preparing them for school, and having more fun with them in a learning-style atmosphere. The last set of students provided some interesting commentary on why learn memory techniques:

I have taught some of the ideas to my two children (girl -5 and boy -7). They both get a great bang out of the list game, especially when they get them all right. Good training for school later, plus it allows me to try teaching them subjects I think are important now before they get into school proper.

(Nursing student B)

I can't believe how fast the kids learn. Both my husband and I have used different techniques with them, concentrating on pictures. We went through the entire Richard Scary's Best Word Book Ever with the four year old over two weeks. I'd say she knows every one of the fifteen hundred words perfectly, including their spellings. We did the multiplication tables like you showed us, up to five's, and she learned them on a Saturday. We had a neighbor that was a teacher before who thought she would be an education problem because she wouldn't sit still and read with her. Now she sits still for long times, as she says "making silly pictures". I think it must be easier for the kids than for us adults who never thought that way before.

(Respiratory Therapy student B)

Obviously, more study needs to be done on the usefulness of such techniques in serving the learning abilities of grade-school age children. Picture-making seems to be part of a normal childhood until the teaching of reading commences in the elementary school. At that point, there is no longer time for day-dreaming or picture making, only for recitation and reading the correct words on the page. None of the participants can recall any teacher ever discussing the use of picture-making as a learning or memory tool.

Memory Training Factors. It was not conceived that the training sessions would be completed without some problems arising. Since such activities had not been done systematically before, it was considered even strongly likely that inherent disadvantages to the development of memory skills might become apparent. However, through the observations of the participants during the workshop and from the final interviews, the disadvantages were determined to be more in the nature of memory development constraints rather than actual limits on memory ability enhancement.

There were two main problems mentioned repeatedly for the training unit. The first involved the need to slow down during the original reading or input of material. The second problem factor dealt with the quantity of techniques available.

A fairly common theme was the requirement that, in order to make detailed ridiculous pictures, the student had to drop the reading speed to well below the levels previously used.. This aggravated several students initially, because they felt it added more time to an already overlong study period. "At first, I resented having to slow down to do mind games, especially when my pictures didn't stick. But by the second week, my pictures were coming faster, and I found I retained more, so the speed was less important," stated one paralegal student. A student in respiratory therapy was more exact: "Until I started forcing myself to be more creative, I thought the system too slow and was going to give up. But after my first quiz, where I went to the trouble of making pictures for every paragraph in the chapter, I stopped worrying about time. First time I ever got a hundred percent on anything."

Some students did not get over the pace problem even after the four weeks. An education student scolded, "The only thing those techniques did was slow me down. I can't make ridiculous pictures, so I stayed with my old ways of memorization and they work fine." Another student essentially reiterated the same thing: "Too much time was wasted making pictures. I'm better off re-reading the material three or four times before a test, at least that way I know I've got it in my memory."

Overall, the pace problem became a minor issue by the second week. Most of the participants had by then seen the value of formulating pictures during the home practices and drills. As one of the professors put it, "Time was a small price to pay for the greater memorization ability I experienced."

The second factor considered a hindrance by several students was the number of techniques presented. This was related to the time problems: the duration of the individual sessions, the once-weekly class period, and the total four-week duration of the course. Most of the students resolved the problem by following the advice originally given by the instructor: take the techniques that you like, or ones most appropriate to your situation, and concentrate on them at the expense of the others. Students that watched their own ability development did just that, clearly not worrying about learning every technique in detail. They decided which ones were most advantageous and concentrated on becoming expert with them. All the techniques were summarized and passed out (a workbook was made available) so that additional work on supplemental techniques could be done either in the future or as the need arose.

Students arguing against the multiple techniques were not often supported by the other students. "If you don't want to learn about it, take a nap till the rest of us are done," was a comment from a biology student to a complaint about the number of techniques learned in one session. "I want to learn everything I can handle, so keep talking," exclaimed the Department Head. One student commented, "With me, since I don't have the faintest idea of what's coming, every technique is just another opportunity. I don't feel like I'm a slave to the tools, but I certainly plan on making them my slaves in the short haul."

After the training sessions, the theme was again reiterated by several students. "I felt I could have learned more if you had concentrated on just several techniques instead of the huge amount we did," lamented one nursing student. "More isn't always better, you know. I think I'd come away with more if we had just done the first two weeks spread over the entire four," exclaimed a criminal justice major. Even those who were satisfied with the training program had some reservations:

You could reduce the stress even more by concentrating on three or four methods only.

(Undeclared student E)

I know there's a place for each method you covered, but the time scale's too short and there's too much crammed into each unit. Maybe next time you can reduce the overload to a minimum and work on pictures, links, and story-lines.

(Biology student A)

Too many things just overloads my brain, just like school often does. When I started worrying about the memory material, I got stressed again, and school started to suffer. The only way to get out of it (since you didn't want us to drop the training program) was to forget about all the fancy techniques and use just the first three you taught. That got me through okay. But too many thrown in at once

had a bad effect on my study habits and school. If I had kept going that way, my grades would definitely have suffered.

(Nursing student B)

Participant Motivation Problems. One of the initial problems to be investigated in this study focused on the role of motivation in learning and formulating memory patterns for long-term recall. It was conceived strong motivational patterns would augment the learning situation, while poorer motivations would actually hinder the success of the workshop. The types of motivation used by students, involving the reasons for participating, were also of interest. It was believed by the researcher as a result of more than twenty years of teaching in the collegiate system that students with good reasons for learning, or strong motivational development, would out-perform those students who either did not take the time to consider their own motives for involvement or were inherently weak in their motivations or desires for success.

The participants were split evenly along the proposition of whether or not they felt their motivation for the workshop was adequate for the sessions to follow. Among original motivations given for participants in the workshop were (in their own phraseology):

need to remember more for school; more memory for occupation; better grades; better concentration; greater comprehension; less time requirement for study; more free time; increased reading ability; friends taking the class; parents said had to; too many new subjects to learn; lack of confidence in memory; poor vocabulary; wife taking course; sounded like fun; earn more money; meet people; remember names better when introduced; do nursing classes easier; remember things longer; write from memory; requirement (better memory) for graduate school; amount of material to learn for medical school; remember chess patterns; retain math and chemistry formulae better; remember chemical equations; better

appreciation and memory for art works; retain the multitude of legal cases; remember promotion manuals; dealing with public; teach own children; teach to children in school; retain dates and events; regain old memory skills loss due to illness; learn foreign language; increased knowledge; liked the idea of increasing memory ability.

There was a broad range of reasons for participating in the workshop, including specific needs for circumstances both in and out of school, in both academic and business/professional environments.

On the first class meeting day, the instructor/researcher asked the class members to write the reasons why they were taking the class during the next week. It was strongly emphasized that the better their motivation, the more results they would see and the more likelihood there would be of completing the class. When interviewed, almost half the class (45%) participants felt that their original motivation(s) had held up though the four week training. Of those students, all either had original motivations including better grades, more free time, and more remembering for school. A majority (61%) wanted a stronger memory for dealing with their occupation, while virtually the same group (55.5%) wanted to use memory skills for remembering names and faces. All the other reasons were individual in nature.

An interesting fact emerged from the study. Those students who wrote down or itemized their motivations for taking the course in the most detail were those that felt their basic motivations carried them through the entire process. In all cases, they included the students that were most pleased with the training sessions, had the least amount of complaints, and showed the greatest improvements in skill levels. As one

student said, "I figured motivation was the key the way you explained it." A student-housewife mentioned, "I found a long time ago if I wanted something I had to put the edge on it by working hard at keeping motivated." The businessman exclaimed, "If I didn't know how to get motivated, my business would have folded years ago. I just applied the same degree of desire here, and it paid off." Finally, a very telling remark came from the speech pathologist on motivation in general:

Developing strong desires is what gets me through the day. After my illness, my brain didn't want to work due to the chemotherapy I went through. I didn't think I could do this (the memory workshop), but I spent quite a bit of time strengthening my reasons for doing it, not the least of which was to regain my old sharpness. My motivation was to practice my profession the way I used to, without sympathy or excuses. All the other reasons, from my husband wanting me to take the class with him, to teaching the kids, all the others I wrote down took a back seat, way way back, to that desire to get back into my career strongly.

Those individuals that either did not write down their motivations as requested, or limited themselves to single or very few motivational reasons were those that agreed their basic motivation did not last through the training session. Several had the same comments: "You didn't say this was gonna be such hard work," groused one nursing student. Another agreed, "I thought learning how to memorize would be easy, but this is just as hard as regular schoolwork. I wasn't prepared for that!" One of the professors, after a long consideration illustrates factors that affect the motivation of adult students when he said:

Dickering around with the games helped, but I found I lacked the energy to keep up with what you wanted as homework. My basic motive for the course was all the work I have to do, but this (the course) just added to it. I can see now I really didn't have much of an interest in developing these skills, what with my farm work, the demands of the University, my accounting work, and my boy's

problems with school. Maybe the next time I'll try it the way you suggested, by faking a slew of motivations so maybe one will work enough for me to get it.

(Professor B)

Motivation apparently plays a highly important role in the success of training programs of any type. Memory skills development is no exception, for without strong motives, the process is difficult, time-consuming, and often frustrating, much like learning any new skill or activity, like driving a car.

Personal Experiences Evaluation. Although the success of the participants was investigated using correlated t-tests, it was important to determine the individual participant views of success or failure of the memory training. One of the goals of the training was to involve the students in the use of Metamemory, having the ability and desire to investigate their own memory abilities, their strengths and weaknesses, how they were applying memory components to daily life, and how they could more successfully access that particular cognitive ability. By discussing Metamemory during the training session, particularly in regards to the components of Organization, Use of External Aids, and Applications, it was felt the students would gain in enhancement of their own abilities.

When asked if the participant memory abilities were better after the training session, 38 of 40 students agreed that they had gained tremendously from the variety of memory techniques presented. Many of the program subsystems, such as the Linking of Pictures and Picturization, were considered of great value in daily activities.

The number and variety of memory enhancement techniques considered useful was extensive. Twenty-one students directly mentioned Picturization as continuously useful in many situations, particularly ones not primarily involving reading. "I process pictures before going shopping now, and I think I save a fortune not buying extra junk I don't need," one nursing student said. "Since my life revolves around my classes, and they're hard, I do pictures constantly to keep the details straight. I just wish my instructors would learn to slow down till I get better at it," another nursing student reported. "I found the best way to watch the evening news is to do it with my eyes shut and make pictures of what I hear. Not as violence or offensive, and my images are getting sharper and more colorful," exclaimed a paralegal student.

Thirty students referred to the value of the Storyline process. "Once I found out how to turn a chapter into a story, learning got a whole lot easier," a male student noted. "Doesn't work all the time, but my comprehension is much better when I have a motion picture to romp through," a counseling student added. "When I turn the ideas into a linked story, I get more of even the tiny details," noted a respiratory therapy student. Similar likes were advanced for twenty-eight students for the Substitute Picture process. For example, many praised the ease at which they could retain new vocabulary by formulating pictures of easier-to-understand or known words. A counseling student stated, "All my courses force me to learn new vocabularies, or what's even worse, they use the same old words with totally different meanings. Some are tough to conceptualize, but since I can always find a sound-a-like to make a picture of, my skill at memorizing

vocab has increased tremendously.” Others liked the fact that they could use parts of a word, a rhyming word, or anything else reminding them of the original word as a basis for formulating a picture, making a difficult or abstract concept easier to picture. As explained by another student, “My hardest problem was with abstraction ideas that were originally just compilations of words. Now I find the pictures help me overcome the abstraction. I have to work harder I guess to understand what’s being said to make the pictures.”

Another common theme that emerged was the use of the Number Alphabet and the Letter Alphabet. Both were widely used (16 respondents), particularly by the science and mathematics students. All the students mentioning this method felt there was a tremendous advantage to these sub-systems. These were modes of memory usage having inherent worth for learning mathematical formulae, chemical equations, and other elements of their fields of study involving isolated letters and numbers. One of the professors stated quite energetically, “I wouldn’t have believed the value of the two systems if I hadn’t experienced them for myself. I’m taking the time in each class to teach them briefly to all my students.” One of the general science students concurred, “I used to dread chemistry, specially organic. Now I learn reaction mechanisms in no time, and can keep them straight on exams, too.” However, one of the science students felt lost, “I’d like to use both systems, but I just can’t. For whatever reason, numbers just won’t stick, neither will the pictures. Maybe I’ve some kind of mental block against it.”

Another emergent theme voiced by thirteen students was the Homeroom Mapping system. Students extensively using this system were ones who predominantly were dealing with giving oral presentations of one form or another, and who preferred not to have to continuously refer to notes. One of the paralegal students said quite gleefully, "She's (the instructor) always requiring us to give five or ten minute summation speeches on the cases. I'm the only one who does it without fumbling through note cards." In this fashion, those mentioning this sub-system always mentioned what the technique did to help them with reports. This was especially apparent in the professors, all of whom liked the technique for giving lectures. "Allows me to proceed faster since I don't feel a strong urge to fumble with notes," said one. Another was more eloquent: I'll have to re-think my lectures. Now the students inform me I am going too swiftly for their note-taking ability. But my brain seems to flow along the topic, I can watch it leap from idea to idea, and I don't feel any need to stop and think."

There were multiple variations of the theme of certain sub-systems being applicable to current problems. Two students found the use of Copy-Cat Words linked together ideal for foreign languages. One said, "Spanish is easier than learning English. I've even shown my Spanish teacher how to use this, and she's spreading it around among the other third-year students." The other exclaimed, "French verbs, once I caught the trick, were so simple to do I learned over two hundred on one weekend. My teacher was, to say the least, impressed when she quizzed me." All the student-housewives liked the Rhyming Number System, especially since it was one they could use with their

younger children. "We'd play games and then he'd just want to read," one explained. A last comment was offered for the use of Memory Charts: "We had to learn the shape of the countries of the world, their capitols, and their major topographic features for Prof. \_\_\_\_\_'s geography class. Before you taught how to develop charts, I don't think I could have done it. As it was, I only missed two shapes, and none of the capitols. You should develop this for grade-schoolers who have to learn the states and their capitols, and where they are in the country."

All of those students finding value in the training were impressed with their ability to do the drills. In that regards, the success with the drills seemed directly linked with their success throughout the remainder of the sessions. In particular, the reasons they liked certain exercises were highly enlightening as to why they like the course in general. Pertaining to specific drills, comments were:

Memorizing lists using pictures and story-lines is so obvious I can't believe no one ever taught it to me before.

(Undeclared student C)

Fifteen years of education, all that geography, and it takes a drill of five minutes to memorize the United States in alphabetical order. When I could do that, I knew this was what I needed for a long time for school.

(Nursing student A)

You know, I was the only one in my class (criminal justice) that knew the Amendments to the Constitution, in order and by number. The professor asked for the technique, since she kept confusing several of them. Turning numbers into pictures and connecting them to pictures for the concepts is really clever. I do that on all my law materials now.

(Criminal Justice student A)

Memorizing poetry was always difficult for me. Not now - I have three more of my favorite poems committed in full after last night.

(Sociology student)

Just for a lark, I took all the dates in my Russian history text, wrote them off so I could check afterwards, and worked on them off-and-on over the weekend. Monday before class I checked, didn't miss a one. Changing dates to picture words, then pivoting them around action sequences is not only fabulous, it's darn right brilliant.

(History student A)

Several comments are worth noting for drills that were given out to be done as practice at home. Two people had strong comments on the Bible drill, remembering the number and name of the books of the bible, and the number of chapters. One criminal justice student, also interested strongly in divinity, stated,

That was the best drill of all. I've always wanted to memorize the authors of the Books, but couldn't bring myself to spend all the effort. Once I formed the number pictures and understood how to make pictures for larger numbers in your Universal Memory System, I applied it straight-away to the Books, and had them all done before dinner on Friday. What a treat, and my minister was delighted with my knowledge

(Criminal Justice student B)

One other student had a strong comment on the game of learning the Presidents and their terms of office. The history student exclaimed,

Dates to pictures fastened onto presidential features with their names turned into pictures and tied to another picture for their VPs was complicated. First ten minutes were tough, but then it got like my brain decided to play the game actively, and it not only got easier but became fun as I became more inventive. Plus, since I know you'll like this, I then went to the major events of their presidencies and added to the pictures in excruciating detail. Dr. \_\_\_\_ asked me questions about them (the presidents), and I didn't miss any. Great technique.

(History student A)

Without knowing it, since it was not assigned as a drill, the method of actively making pictures was used by many (9) students while reading novels. The researcher had originally thought that everyone involved in reading a novel automatically made pictures while reading. This was clearly not the case. The nine students expressed delight in being able to follow story plots better and in a more enjoyable fashion when they made pictures while they read. One statement, from a counseling student, summed this idea well:

Before when I read, I could tell you the basic plot, some of the more colorful incidences (especially if they involved sex). Details were very few. When I picturize (is that a word?), I get the whole book like watching a movie, I hear the voices and words, sometimes even smell the flowers or the stink of someone's sweat. I've gotten good enough that when one of the convicts hit a guard in the story, I felt the punch! Talk about making a book exciting! Now I'm working on making, like you suggested, the pictures bright colors, like fluorescent greens and pinks, adding more movement, switching to three-dimensional pictures, and putting lots of action. I have to tell you, reading had become a tremendous chore over the last couple years. Not any more, which is why I think my grades went up also.

(Counseling student B)

Perceived Benefits of Memory Enhancement.

After performing the diverse exercise and drills associated with the training regime, it was thought by the researcher than student participants would be able to develop and appreciate numerous benefits of ownership of enhanced memory abilities. This was expected to carry over into educational activities, business activities, and personal lives. Information on this aspect of the training was garnered primarily from the personal interviews near the completion and after the training sessions.

The knowledge required to keep current in most fields of study is rapidly expanding. Globalization is changing patterns of business and technological interactions present today. In this evolving context, increasing the memory abilities should be considered beneficial to the students in a particular field or business. Likewise, it would seem beneficial to any business person interested in staying competitive by keeping abreast of current technologies and opportunities.

The participants in this study almost universally agreed there were benefits of learning to use memory skills better. With the exception of the two students who felt there were no benefits attributable to the training, the remainder felt that benefits accrued in education, in business, and in daily life. For education, those students felt it helped in respect to learning faster, easier, and more material in greater depth. The accounting student was typical: "Class work couldn't be simpler if he gave us all the answers for the tests." A chemistry participant commented, "I am not totally comfortable yet, but chem. problems got a whole lot less headachy." Another stated, "This is a no-lose situation. My memory's so much better I can even take more credits next semester and finish sooner."

In dealing with business problems, there were two different sets of remarks. These were separated by the fact that one set came from persons owning and maintaining their own business, the second set came from persons working for others (i.e. secretarial staff and military staff members). The student running the printing business was very adamant about the use of his new skills:

There is so much competition in town now I wouldn't have a chance of remaining open if I didn't keep up with the newest technologies. That requires long hours of reading and digesting trade articles to determine what will fit in here (I've recently expanded three of the departments, bringing in laser four-color printing and two new techniques for reproduction). Everything I have learned in this class will pay dividends in the future. My business has increased because of my customer base, whom I all know by name and about ten tons of trivia for each of them. My front-desk staff, whom I have shown that first session material to, use it conscientiously to get people's names right, to make them feel comfortable in the office. Plus they act for me - they know what needs to be done, how much it costs, and basically how to do it. So I can leave without worrying about things dive-bombing through the floor while I'm gone. I'd be the first to admit I didn't learn everything, nor did I spend as much time practicing as I should have. But what I did learn has given me great benefits already.

(Business student)

The other business people were just as positive, but from a different perspective.

The secretary stated, "Benefits for me means faster advancement, promotion, a bigger pay check every two weeks. With the compliments clients have been giving my bosses on my abilities and my attentiveness to their needs, it's just a matter of time." One of the members of the military stated quite matter-of-factly, "Promotion because of the skills is a done deal. I even have others in the same office offering to pay me to teach them how to get through the tech manuals so fast." Another student still in the military explained, "Since I'm doing school and the military simultaneously, ask my wife about the benefits. Now I'm home more, not spending all weekend studying, not getting an ulcer worrying about flunking some rinky-dink course, and should get my next promotion about six months earlier than I had planned on before." Finally, the police officer was a strong advocate of the training as to benefits. "Better people-skills, better communication-skills. I'd even swear the training has influenced my use of firearms (my scores have certainly

gone up on the range). I don't know the long-term benefits, but I am certain they are there."

The data from the interviews indicates that is a strong need for adult training in memory enhancement techniques. The benefits as illustrated in the aforementioned quotes indicate that with a strong motivation (i.e. promotions, family time, grades, development of individually identified applicable skills), students can be self-directed in learning new techniques that are suitable in solving their particular problems or are applicable to their individual situations.

### Kolb Learning-Style Questions

Orientation to Approaches. In dealing with anything new, such as this workshop training for memory, many people carry a set of expectations that influence their initial reactions to beginning such training. Such expectations would conceivably be formed by an individual's perceptions of any possible advantages, such as monetary gains, or disadvantages, such as failure to succeed, apparent for the training system. Adult learners tend to focus on what they have as a particular goal or need: if the course of education does not seem to fit their particular needs or desires, the disadvantages will typically outweigh the advantages, and the educational process will most likely be terminated. Students in the workshop were immediately faced with that situation: to determine whether or not the memory enhancement sessions would be suitable for them, or should the effort of studying be saved for a more rewarding experience. A typical

comment came from a criminal justice student. "I expected it to be somewhat difficult, and it was all of that! I wasn't sure I should really sign up, so I'm glad my girl friend convinced me to do it."

There was no perceived association between reluctance or hesitancy to take the memory training and Learning-Style. Fifty-two percent of the participants (3 Convergents, 5 Divergers, 6 Assimilators, and 7 Accommodators) expressed initial reservations in doing the program. When asked to elaborate on why the hesitancy, most referred to lack of time or other commitments. Several were more opinionated (including 2 Convergents, 2 Divergers, and 3 each of the Assimilators and Accommodators). One example speaks for all: "I'm always a trifle uncertain about starting new things, especially when I have so many old problems to deal with. I'm not sure of my ability with memory, so why chance something I might fail at when there are other things I am sure I can do?" Another Accommodator, a science student, added, "It's like any other course. At the beginning, I'm usually scared enough I can't concentrate. Gradually I'll get over that (unless I flunk the first quiz). But dealing with new classes is like dealing with new boy friends. It's a real tentative go-round till I get a better feel for what's happening."

Preferences. As established by Kolb, the Learning-Styles should show up in the manner in which students direct their learning activities. For example, Convergents tend to find practical uses for ideas and theories. They prefer to deal with technical tasks and problems than with social and interpersonal issues. Conversely, the Accommodators

would enjoy carrying out plans and involving themselves with a heavy reliance on people for information. The use of the learning steps of Abstract Conceptualization, Active Experimentation, Concrete Experience, and Reflective Observation should clearly establish preferences in learning activities.

Among the problems encountered during the first weeks of the workshop was the difficulty forming ridiculous or exaggerated pictures for many of the students. When asked to explain the problem, several indicated it was due to a prior educational training that literally forced them to maintain contact with concrete reality at all times, to avoid flights of fancy or day-dreaming as non-productive activities. A biology student explained, "I got into trouble more than once in parochial school for letting my attention wander, what you'd call day-dreaming. A couple of ruler whacks and that stopped pretty much for good." A criminal justice student explained what reading had to do with it:

When we read, outloud, we couldn't skip words, mispronounce them, or add anything that wasn't there. You didn't have time to make pictures. You could always tell the kids in trouble cause they were doodling all over their book covers and notebooks when they were supposed to be paying attention. Funny, isn't it? Now you want me to participate in designing pure flights of fancy as you call it, and forget about keeping my feet firmly on the ground. I'm not sure I can do it. I may be just too old, too set in my ways.

(Criminal Justice student B)

Among the students preferring concrete reality over day-dreaming or making exaggerated mental flights of fancy, 3 were Convergents, 6 Divergers, 8 Assimilators, and 7 Accommodators. No particular pattern seemed to relate Learning-Style to the necessity of being more "feet-on-the-ground" than spending time making mental picture games.

Likewise, in the preference of hands-on experience to abstract mental ones, there was no discernible pattern with Learning-Style. Two Convergents preferred each experiential type. 4 Divergers preferred hands-on experiences, as did 6 Assimilators and 9 Accommodators. 5 Divergers, 6 Assimilators, and 6 Accommodators decided they preferred mental experiences. However, there was a rather strange occurrence with this question. When asked the question on preference, six of the students visibly hesitated, finally deciding on the side of hands-on experiences to start. Before the end of the question session, however, they had each changed their view to that of mental experiences. In response to further questioning, no reason was given for the change in viewpoint except for a single explanation by a paralegal student: "I guess after thinking more while talking I really prefer working with my brain rather than my hands." The other five students said essentially the same thing. It is conceivable that, with longer conversations, others of the group might have also reversed themselves in either direction.

Individual or Group Interactions. There were two primary tools for investigating the nature of student Learning-Styles besides the approach offered by the Kolb LSI. These were the use of the interviews at the conclusion of the training, and observations of the students during the classroom sessions. On the basis of these data gathering techniques, it was considered possible to identify specific Learning-Styles.

If there was any question that might be related to Learning-Style, the choice between being an active participant or preferring quiet meditation should have indicated different styles easily. Nine Accomodators preferred group activities as contrasted to only 6 in the Accomodators category preferring mediation. Among the Divergers, 6 participants agreed group activities were better for learning, while 3 preferred individual meditation. Among the Convergers and Assimilators, there was an even split for each mode of activity. The number of students preferring each activity in each Learning-Style, however, is not apparently significant, since there was no clear preference in either direction for a large majority of the participants.

Learning-Style Variability. Through a chance statement made by one of the participants upon receiving the results of his Kolb LSI, an additional minor area of investigation was explored through follow-up questions. Although it was not a formalized question, students were asked upon finding out their preference on the Kolb Learning-Style Inventory if they agreed with the determination of the Learning Style category to which they were assigned by the LSI. It is interesting that of the forty students, sixteen (40%) thought they were better represented by another style than the one they were assigned to be the scoring mechanism. Reasons for this discrepancy included:

I'll bet how I answered those questions depended on the time of day I took the questionnaire to work on.

(Undeclared student B)

Some of the questions are vague enough I could have answered them a slew of ways.

(Chemistry student)

There were questions I wanted to answer "none of the above", but that's not in the guidelines. Maybe my scores would change for the better if I picked answers on what I wanted to be later.

(Accounting student A)

I'm going to med. school. Why would I ever come out an Accommodator. I like thinking with my head, not my hands. And I'm sure not ever going into sales. Look at one of those questions, the one (I think) that said "When I learn...". I use all those things. so they all should have been 4's. Couple more of those and I'd be where I know I am, an Assimilator.

(Biology student A)

A math student as a Converger? That's great. I'm in math because I love abstract math concepts, manipulating them in my head and doing problems. If I wanted active experimentation, I'd have gone into physics. I'm an Assimilator, through and through.

(Mathematics student)

In education, teachers need to be Accommodators. We're working with kids all day, using our knowledge to foster hands-on activities instructing the little brains. There's not a whole lot of time for reflection or being abstract. If I were to chose, I learn best by being an Accommodator.

(Education student B)

Of the participants, twenty -four students were satisfied or felt they were assigned to the correct Learning-Style. One criminal justice student added, "My style doesn't go with my future career as the inventory sheets suggest. But I think the way I learn is best reflected by the Diverger style." No one else had any particular comments on the Inventory results. With 60% of the participants being satisfied with their category placement, and 40% dissatisfied, the results are inconclusive as to whether the results of the Kolb LSI would give different results under different circumstances.

## CHAPTER 5

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to investigate the teaching of memory enhancement techniques to adult learners at the college-level of education. Both quantitative and qualitative methods of investigation were used. Correlated sample t-tests were used with data gathered from pre- and post-testing over the techniques introduced. Additional studies were done with data gathered from qualitative methods using interviewing and participant observing, which were employed during the scheduled training sessions and afterwards in final interviews. Students in a wide variety of majors participated. Working students were from a variety of areas, including education, local businesses, and the military. Some individuals designated themselves as housewives. Additional data was generated by the use of an initial questionnaire, application of the SKILLS instrument to indicate Metamemory use, and the Kolb Learning-Style Inventory. These multiple techniques were to triangulate the data acquired in this research.

Several significant findings came from the initial questionnaire. Participant data showed no particular association between the amount of education they had previously and their own perceptions of their memory ability. Further, quite contrary to what was expected, the amount of time spent reading per day did not compare well with any memory ability. Finally, the data indicates that, at least for the students participating in this study, memory training is not part of the normal curriculum in public schools, nor is any instruction in learning techniques presented in a formalized manner.

The application of the SKILLS instrument provided evidence for several additional findings. The majority of students did not consciously do anything in terms of organization strategies for committing materials to memory. Although students with higher SKILLS scores, indicative of more awareness of their memory abilities, occasionally use External Aids, those participants with low or average SKILLS scores use such assistance extensively. This deliberate limit placed on memory use was amplified by the lack of any attempt by the majority of students to even address the issues of looking at or working with their memories. Very specifically, the data suggests students normally take their memory for granted, accepting it as it is without further consideration or attempts at improvement. Basically, what is used is whatever works to solve the problems or deal with the issues present in the immediate environment without recourse to additional learning.

The Kolb Learning-Style Inventory instrument has been shown to discriminate between students on the basis of four Learning-Styles. A major finding using the Kolb

Learning-Style Inventory instrument was that no particular relationship between Learning-Style and either memory ability or the ability to enhance memory skills through training provided in this study occurred. Rather, each student's ability to learn and function with the diverse techniques discussed depended more on their personal preferences, their field of study within the university or college environment, and several external factors, such as occupations and the presence of children in the home.

In addition to the basic issue of relationship between Learning-Style and memory enhancement, it was discovered that there was no clear relationship between reluctance or hesitancy to try new things and Learning-Style. All four Learning-Style groups had individuals that expressed initial reservations, but each also possessed participants that enjoyed the challenges of trying new methods. The major problem noted, for example, with the instructions dealt with the ability to make mental pictures. This factor cut across all modes of Learning-Styles. No clear pattern was shown for preference in using concrete reality as compared to day-dreaming or "flights of fancy" despite Convergents, for example, tending to be more practical in their usage of ideas and theories. Similar issues arose with the preferences for "hands-on" experiences as contrasted to abstract mental ones. Although Assimilators are credited with combining learning steps of Abstract Conceptualization and Reflective Observation, their Learning-Style showed no more particular correlation with those aspects of memory training involving abstractions and mental constructions than did any of the other three Learning-Styles. No relationship was found between choice of activities (i.e. being an active participant or

preferring quiet meditation) and Learning-Style. Observations and interviews were used to confirm the Kolb LSI determinations.

A major portion of the findings of the research came from the use of pre- and post-testing in conjunction with the interviews and observations of the participants. The t-tests indicated that training for each of the memory sub-systems included in the instructional modes caused subjects to enhance their memory abilities, with the greatest improvements occurring in the ability to remember Lists of unrelated material, Ordered Objects in which sequencing is important, and in retaining Names-&-Faces in both educational and social settings. Broad patterns of likes and dislikes were discovered, including an almost unanimous agreement on the success of the training sessions. The viability of individual techniques depended on the nature of the participant, what major was being studied, and the requirements for both education and work that the student felt most strongly applied to himself or herself. Different techniques such as Picturization, Storyline, Number Alphabet, and Letter Alphabet were cited by various participants as the most important, while all the remaining techniques, with the exception of the two most complex, added to the student's repertoire as needed. The last two techniques discussed, the Recall Patterns and Mental Mapping, were considered too difficult and time-consuming to be of much value to all but a very small minority of the participants.

Numerous advantages of the training were perceived by the students, with the greatest advantage being the application of new skills to school situations or business dealings. Many students found the training material carrying over into daily life.

Advantages traversed a range from simple grade increases to general ease of learning, from promotions gained by enhanced memory ability to contributing to the education of children, and from developing successful business practices to enhancing clientele appreciation of business effort. Over forty specific advantages were cited by the student participants, with the most common being development of free time, increased concentration ability, increased comprehension, better grades, and improved test-taking ability.

In addition to advantages, it was discovered that there were several problems in the training that all participants experienced. The major problem areas were in the formation of interactive mental pictures and the inability to make such pictures rapidly. In this regard, many of the participants noted the time constraints of the class work, including the three-hour sessions, the once-a-week meetings, and the four-week duration of the workshop, as being inadequate for developing fully their memory abilities. Furthermore, many participants felt that techniques not germane to their particular interests were wasted time and energy and should be removed. It was clear that only when technique material was made relevant to the needs of the learner were they adequately attempted.

Also, the role of motivation in providing training in memory skills development was shown to be quite strong. Students with strong original motivations, including such reasons as better grades, more free time, and increasing concentration ability, found their motives sustained them through the four-week process. Participants with weak or

singular motivation had problems with successfully completing all aspects of the workshop.

In addition to the preceding issues, it was discovered that the instructional techniques used were considered quite adequate by the participants. Individual likes and dislikes dominated in dealing with specific memory enhancement techniques. The only problem consistently agreed on was that of the time element for the course. By the end of the training experience the majority of students found extensive value in the training as applied to their normal routines. Issues such as a plenitude of diverse techniques, the need for slowing during reading to formulate detailed pictures, and the amount of effort required to master individual modes of memory enhancement were dismissed by the participants as generally unimportant compared to the benefits derived from learning how to use and enhance memory skills.

### Conclusions

#### Conclusions for Teaching

Based on the findings that have been derived from this research study, the following conclusions pertaining to the teaching of memory enhancement are drawn:

Even students with no prior exposure to the ideas of Metamemory can benefit from training that embraces the components of Metamemory.

Learning style as set forth in the Kolb framework of Learning-Styles does not yield information for prediction of an individual's success in training for memory enhancement.

Learning style does not affect the way students learn memory techniques, nor does it limit the individual to a specific set of enhancement techniques.

Motivation is a key element in the success of a student in learning, assimilating, and using memory enhancement techniques.

Regardless of the learning style of an individual, individuals at any level of prior memory ability can benefit from memory training.

### Conclusions for Memory Enhancement Training

Based on the findings that occurred from this research, the following conclusions can be made for the training of memory in college students:

**Attention:** A fundamental element of memory ability depends on paying attention to what is being learned. Any procedure that helps focus the attention or concentration on the material to be learned will be beneficial.

**Motivation:** The factor of motivation is essential for memory. Individuals remember well only that information they have a particular desire to retain. Motives can be positive (i.e. better grades) or negative (i.e. fear of failure) as long as they are strong. The more motivation applied to a task, the greater the likelihood for success.

**Structure:** Material has to be structured in a fashion that can be recalled with ease at a later date. By converting any concept or idea into enhanced pictures differing from ordinary images, the brain has easier access to them for retrieval later. The process of converting material into pictures forces concentration, resulting in increased awareness of the material, increased comprehension, better and clearer formation of memory traces, and substantially better recall.

**Imagination:** The use of imaginative processes is a key element of memory ability. Any use of imagination resulting in transformation of data into visual representations that do not necessarily exist in nature will assist future recall and memory pattern associations.

**Rehearsal:** The reviewing of material is most often essential for forming long-term memory patterns. The amount of rehearsal necessary for an individual

depends on the concentration applied to the learning process, the difficulty of the material and the technique being used, and the abstractness of the information. In general, three sets of repetitions converts the majority of information into recallable patterns.

Sequencing: Students develop memory abilities and enhanced skill levels faster when the material is presented in a fashion that allows the individual to have fun in creating the necessary components of a memory trace. This is not restricted to making pictures, but occurs in doing rhymes, creating stories, or visualizing interactive events. The more activities encouraging fun participation involved, the easier the memorization becomes.

Memory skills can be taught and enhanced in students at all levels of memory development. The process involves teaching directly, like typing or acting.

### Discussion

The implications from research findings and conclusions drawn from this study have great potential to be far-reaching in several diverse areas. These implications exist in the areas of learning strategies, teaching strategies, educational needs and requirements, the appropriate use of instructional techniques, and approaches to student involvement and encouragement.

#### Learning Strategies Implications

Student Involvement      The research done in this study suggests that all adult learners can be trained to some extent in information-processing strategies. However, because students in diverse majors appear to bring different approaches to any learning project, in either demonstrating and explaining memory strategies or learning strategies, the instructor must continuously monitor the success of the techniques being employed in

the development period. As evidenced by this case study, few students in the workshop enjoyed thinking in the abstract. The majority of students not only disliked it but attempted to avoid it in most instances. As a consequence of this dislike, the instructor should carefully evaluate which techniques are working and which may have to be modified to satisfy the needs of the majority of students. It was evident from the interviews that practical applications, particularly as related to topics germane to the individual, and hands-on experiences in the form of interactive demonstrations were highly preferred over theoretical discussions. Knowles (1970) pointed this out as one of the fundamental principles of andragogy: adults learn for the immediate application of the knowledge they acquire.

Kolb Learning-Styles For many years the implicit assumption involving learning was that it was a generic process remaining the same from one situation to another. In this case it has been shown that learners actually use various strategies, associated with diverse learning styles, to accomplish their learning requirements. However, this study illustrated a problem in using the Learning Styles as derived from the Kolb framework. Since there was no clear relationship between Learning-Style and memory training ability in this group of study participants, the majority of individuals would probably feel comfortable with materials being presented in a variety of formats. The need for the Kolb Learning-Style Inventory as a tool for determining preferences towards the memory techniques appears at least for this study group unnecessary,

especially since the preponderance of students showed a strong dislike for abstract theorization. It is equally clear, for this particular case that the four Learning-Styles intermix in such a fashion that individual preferences, emotional issues, likes and dislikes, and intellectual ability (i.e. low or high rankings of memory scores as indicated by the SKILLS instrument) allow for continual change from one style to another with apparently no detrimental effects on the student's abilities. By concentrating on the basic memory skills and including a mixture of theoretical conceptualization, mental reflection, and active experimentation or hands-on experiences, the instructor is certain to find something that works for every member of the class.

Learning Strategies      Learning was defined in a variety of ways, such as relating to the change in a person's behavioral patterns as a result of repeated experiences in a given situation. Those changes (Bransford, 1979) are governed by learner activities (i.e. cognitive processes used to encode, store, and retrieve information), learner characteristics, the nature of the learning material, and the nature of the evaluation tool directed at the learning after it has occurred. A learning strategy then could be considered as a plan the individual uses for dealing with the learning task. For any situation, the student then needs to be able to analyze what is needed, plan how to attack the problem (e.g. which memory technique is most feasible), implement that technique, monitor the results during application of the technique, and modify the technique as needed. If the memorization and learning project is not viewed as going satisfactorily, the student will

have to reevaluate and modify all the steps as essential for a satisfactory completion of the learning experience.

### Teaching Strategies Implications

Student Benefits . . . Virtually everyone can be taught skills involving memory, with concomitant increases in learning ability and interests in further self-improvement. There are strong implications in this for the future. It is becoming evident that training and education among adult learners must go a large step beyond the simple manipulating data practice and testing feedback that is often used. Although many educators value the importance of hands-on learning, this technique used a tremendous amount of a very precious resource for students: time. Plus, there is no guarantee the student will learn what was intended from the experiential sessions. Complicating this is the fact that some subjects, such as arithmetic or spelling, are better taught in ways that require some form of memorization, either by rote or by more innovative techniques. In place of simply manipulating information, it would seem more efficient to provide a form of more substantive training on the processes, ideas, and styles of learning and skills that are involved in the performance of a specific task.

The more significant implication from this study may be that specific instruction in the more concrete ways of thinking and learning may be beneficial to all students, especially those with poorly developed or inefficient study strategies and skills. A keystone of experiential education is the belief that when asking a student of any age to

complete a task, the most useful strategy is to demonstrate and model alternative methods to proceed. Developing games and activities that place the learning in an environment associated with fun in place of the typical educational environment associated with confined spaces, forced attention, restrictions on activities, and often boredom tend to enhance student interest, ability to remember, and subsequent retrieval of information. Such activities appear to work on two levels, one cognitive and the other affective. When students are given cognitive support, they tend to use effective learning strategies. This in turn helps to break the "failure" pattern many students have developed, patterns that are expressed in sentences like "I can't memorize anything well" and "Why bother memorizing anything anyway, since I can always look it up?"

Needs and Necessities A current idea dominating the educational scene is that of a global community, in which events in places people are not even directly aware of can quickly disrupt or alter the daily lives of millions of people. Accompanying this interaction is a virtually dizzying rate of change in many fields, including science, technology, and banking to name only a few. Add to that an exponential growth of knowledge and the average individual would be nearly overwhelmed. To compensate, it is obvious that learning has to not only become a life-long occupation for everyone, but also must be an activity that can be done smoothly, quickly, and with a minimum of conscious effort. That alone would mandate training for strategies that involve guiding

performance into individual awareness of abilities, with the enhanced ability of altering one's learning as the need is perceived.

Such awareness of one's individual potentials and the ability to vary viewpoints and learn as necessary would seem to necessitate long-term educational efforts. This set of long-term needs must be based on prior learning and experiences held in storage for just such an eventuality in long-term memory. Without the development of such memorization abilities, so much becomes inaccessible or lost that the formulation of carefully thought out or considered decisions would be reduced to simple answers based on last-inputted data.

Developing Aptitudes      A major theme derived from this research indicates that abilities and strategies, and methods for training such abilities interact at a number of levels. Any attempts to develop skills depends on the interests of the individual involved, motivations, learning interests, and prior aptitudes. Acquainting students with metacognitive strategies is worthless unless ample guidance is provided to first familiarize each individual with their own learning style, the one best suited for their particular use at that particular moment in time. It seems apparent that learning styles are changeable, in regards to maintaining a life-time spent in any one particular learning style. At least from the participants in this case, it appears student learning styles are more an intermingling of features, with students taking elements of each learning style that are felt appropriate to the circumstances at hand. Training students to recognize their

own intellectual and learning style and formulating the ability to modify those styles as needed would seem to be, from this case's interview data, a necessary goal for future educational successes.

Another important element comes from the successes portrayed by students with more extensive use of memory skills. Simple practice, with associated feedback on the successes and failures of a technique, is highly effective with even average students and may provide the best training for students already somewhat proficient in the ability to use their memories. There are techniques that can be universally taught to the advantage of all learners. Mnemonic devices, which are often what these techniques are referred to, are so common that most students use some form of them for preparation for exams without thinking of them as mnemonics. Their function, as Norman (1976) has said, is to "... teach the user to pay attention and to learn how to organize" (p. 131). Equally, there are techniques that are apparently so difficult that they become more intrusive than helpful; such strategies probably do more to disrupt effective learning techniques so that their usability would by necessity be limited to those more advanced learners that could find advantages to their applications.

Successful Techniques An important step in teaching memory strategies is evident from the interactions of the students with the diverse memory strategies. This step involves training to improve abilities with the recognition that the most success comes from capitalizing on the learner's pre-existing experiences and strengths. Almost

all successful memory techniques make use of the individual's experiential memories in forming patterns that are important to the single individual. Forcing of another person's images onto a learner only leads to confusion, poor memory association development, and subsequently loss of both memory traces and interest in the proceedings. It is only through the manipulation of elements that are important to the individual, ones that are perceived as providing an advantage or promoting a favorable activity or outcome, that a teacher can actually influence students in a positive fashion. Anything else is just as likely to have a negative impact on the learner, perhaps ultimately driving him away from showing any interest in future learning activities. The entire position was stated nicely decades ago by Norman and Bobrow (1975):

We believe that the aim of cognitive processes is to form a meaningful interpretation of the world. That is, the sensory information available to a person at any moment may be gathered together and interpreted in terms of a coherent framework. We assume that past experience has created a vast repertoire of structural frames or schemata that can be used to characterize the propositional knowledge of any experience. (p. 119)

Finally, it is clear that some people can be trained in developing, while others can not. For the students with low or average memory skills, virtually any step forward is an improvement as they view it. Even the simpler techniques pay tremendous bonuses when developed to the point of being usable in any situation. One of the ramifications of such early successes is the increase in confidence instilled in the individual, quite often a person who has learned to react negatively to learning experiences through prior failures and unsuccessful attempts. Confidence helps in developing motivation. Strong motives

generates better concentration, which augments comprehension. Solid concentration facilitates formation of memory trace associations, allowing for easier recall and subsequent retrieval as needed. Success in recall as needed further generates confidence, and the circle is complete. If education is primarily an aptitude and attitude development program, it would appear one of the best mechanisms for generating positive results would be the implementation of a strong memory training program.

Current Controversies Unfortunately, experiential learning as a major teaching strategy has many critics, especially as regards memory usage and enhancement. Some researchers (Bolles, 1988; Izawa, 1989) consider the use of mnemonics as gimmicky, viewing their use in such learning as concerned more with technique and process than content and substance. Many educators find it too thoroughly pragmatic, dangerously associated with the disturbing anti-intellectual and vocationalist trends in American society (Kolb, 1984, p. 3). Further research that clearly illustrates the advantages of memory training needs to be further disseminated so that such viewpoints can be squarely met with data and conclusions showing the untenable problems of those positions.

### Educational Implications

Current Practices      Given the long and eventful history of research on memory, one might assume that the importance and implications for classroom practice for the adult learner would already have been firmly established. For example, an interesting study (Whimbey, 1976) had shown that adult students in college approach their school work differently depending on whether they were good students or ones with academic problems. Those with problems read difficult material straight through, ignoring the lack of comprehension totally. Good students used what are considered as Metamemory strategies to focus on what was important. However, as evidenced by the participants in this study, basic memory training is virtually non-existent in American schools that these participants attended. This lack of training could be rectified as a result of this and similar studies. In such studies it was discovered that performance improvement was possible by teaching students how to organize materials and how to become aware of what they were understanding and what they weren't.

Themes & Goals      In this researcher's opinion, although there is not a universal acceptance among students of the importance of memory skills, the development of such memory ability is of necessity right in line with the themes pertaining to the goals of education. Those themes and educational goals vary with the emphasis of particular educational theorists and philosophers. They can be summarized generically. First, the educational institutions in America exist for the fundamental

purpose of preserving knowledge. That knowledge, to be of any lasting value, must be passed on to the next generation. Second, education plays a role in developing, selecting, and further training of individuals whose talents will serve the entire society. Finally, and most importantly, education is responsible for the preparing of humans for future stages of life. In this regard, educational systems instill an "aptitude development", forming the values an individual places on education and learning in the context of what society offers and subsequently pays for. Unfortunately in America the instilling of those values seem to be lowered as attested to by the continual ranking of American students well below the median during international testing. Part of this problem can be directly laid to the lack of instruction in memory skills and learning style development, with a subsequent lack of interest for many students in anything remotely related to learning or school.

### Appropriate Instructional Techniques

Organizers and Associations      It became clear several decades ago that advanced organizers of some sort were essential for facilitating the learning of any materials, either simple, complex, or abstract (Ausubel et. al., 1978). Such organization methods as presented in this study were shown to improve the learning of subsequent materials. There are two caveats that should be noted, however. First, materials being learned must belong to a single topic or be related in an easily-recognized fashion. The techniques presented, with the exceptions of that of Recall Patterns and Mental Mappings, makes use of that idea, using the association of materials to enhance

memorization and retrieval. With more complex topics, there is a need for the two methods that were shunned by the students. To get around the problem, however, only involves breaking the subject matter down into simple topics and using the organization techniques for each individual set.

Second, it is essential for the student to be aware of what is already locked in the brain as memory traces. This allows for the development of continual associations with pre-existing information, forming a network of pathways that allow for more coherent and systematic recall. To assure student facility with his own mental abilities, the cognitive concepts of Metacognition, Metamemory, and probably Metamotivation should be clearly introduced near the beginning of the learning exercise. An essential part of memory use is reviewing mentally what was read, experienced, or inputted. The ideal situation would be to spend as much time reflecting on what was learned as was spent in the learning process. Unfortunately, the ideal situation is far removed from the world in which students complain over having to proceed slower because of the time necessary to make active pictures. The instructor of such memory and learning skills has to make the best of the time allotted, presenting and demonstrating the techniques that appear to appeal to the majority of students.

Presentation Elements      The research in this study verified several elements that are essential for presentation of techniques. Visual images are remembered much more effectively than words. Visual learning as contrasted to auditory learning or

kinesthetic learning in learning style appears to be the dominant orientation in the majority of persons. Associations which are formed through the action of imagination are much more easily established and maintained than those formed abstractly or by simple reading of material. Memory is enhanced by repetition, use of created organizers, and through emphasis on past associations and networking with previously acquired knowledge.

The most important teaching methods are those that stress connecting newly acquired information with knowledge held from prior experiences in the brain. These processes of association and elaboration seems to guarantee a far greater yield upon memory retrieval than any other technique. Instructors need to apply such a teaching approach in a three step fashion: (1) be conversant with each student's knowledge base or lack of experience; (2) attempt to create learning situations that tend to overlap or interact with the established knowledge level; and (3) provide numerous opportunities for the students to reflect on and actually investigate the connections that are being established in their own minds. By doing this, the instructor should be able to see students acquiring the ability to define and analyze their problems, plan out the proper solution strategies, formulate alternative methods of attack, check the credibility of their answers, and adapt integrated techniques for use to different categories of problems.

Memory Enhancement  
and Student Involvement

Requirements for Success      This study has clearly shown there are several necessary elements present for success in memory training that revolve around the student participant. First, there needs to be an activation of the student's current knowledge base, allowing prior knowledge to be accessible to be related to any new incoming material. This activation process is best done by starting with simple techniques that allow for immediate successes on the part of the individual, thus assuring a positive framework for subsequent developments. Such simple techniques as Picturization and Storyline would work in this process. Second, new techniques must be taught to the student in such a fashion that subsequent materials can be related to the techniques in a constructive learning process. Such techniques as the Home-room Mapping, Number Alphabet System, or Recall Patterning would be appropriate here.

Third, it is clear that motivation plays a critical role in learning and developing skills. It is essential that the student study his or her own motives for learning a subject. By putting down the motivational elements in writing, the student is forced to confront any problems that appear to rise in the course of instruction. This part of Metamemory would allow for possible solutions that would be used to head off problems before they arise. The instructor can assist students by describing types of motivations and participating in a brain-storming session involving the entire study group.

Finally, the student needs to become intimately involved in developing the memory skills. Several important attributes of that involvement should be shared with the student at the beginning of the training. The student should be made aware of the influence of stereotypes and personal beliefs on the memorization process. He should be made to monitor his own attention level since concentration is one of the largest keys to successful memory enhancement. He should advance slowly, with extreme elaboration, learning each of the techniques in enough detail to feel totally comfortable with the current mode before moving on to another form. The student should be instructed on the importance of making usable retrieval clues at two points, during both acquisition of information and during retrieval. By the end of the training, the student should feel capable of turning abstract information into a meaningful form organized in a fashion to facilitate comprehension and recall

#### Recommendations for Further Research

A number of potential areas for future research have been raised by this study. Some are controlled by the nature of learning, while others are focused more on the nature of the techniques used in memory enhancement.

Mnemonic techniques are based on the same type of cognitive structures and processes as are other types of learning. In that regard, proficiency with such techniques are related to the entire issue of skill learning. It was clearly shown that some of the mnemonic techniques require a great deal of skill before utilization can be performed.

First, it would be helpful to know the effectiveness of mnemonic techniques as learning tools when used on expert learners, not just beginners with a limited amount of training. It is entirely possible that the memory processes and structures that students just beginning in a field may use may be different from those who already work in an area. For example, the value of making bizarre or ridiculous pictures may be different for beginners and experts. For a second example, children with a much smaller knowledge base may find such image visualization to be a very useful means of committing information to memory. Discovering the nature of any barriers to such learning is highly relevant to the idea of a teacher in grade-school providing guidance and effective memory procedures to be implemented by younger children.

Previously it was mentioned that research was performed on developing memory procedures in the classroom for children with learning disabilities (Scruggs & Mastropieri, 1990). The use of Picturization and Cross-Words as means to acquisition of language skills, either English or a foreign language, should be easy to document in a well-structured experiment in the grade-school environment. As a comparison, similar studies could be applied at the college level to investigate the effects of age development on memory techniques learning ability.

An interesting study would be that focusing on the time element. How long would it take the average student to become truly adept in using a single technique or in developing skills in managing all of the memory techniques? Indications from this present study are that the time period involved would be about the same as that required

for developing any new skill. Related to this would be the outcome for students who are offered longer periods of practice. It is not clear whether skill level is determined primarily by practice imposed during classroom situations, or if it is fixed by individual differences controlled by internal (i.e. genetic) or external (i.e. physical environment) variables. Associated with this is the lack of knowledge of the effect of individual differences on performance increase or decrease with practice.

Other areas of research are numerous. It would be of great benefit to determine the difference between the use of a memory technique for a single episode as contrasted to using the same technique for multiple episodic activities. It would seem there would be definite possibilities for interference in learning to occur when the same system is used repeatedly in a brief interval of time. In that respect, it would also be important to know the duration necessary between subsequent usage of the same system. Since the current study indicates that strategies for memory enhancement can be taught, it would be advantageous to continue with a determination of exactly which kinds of strategies are best for average students. Along the same lines, a sharper determination of what it is about those strategies that makes them better than others would be helpful in deciding the appropriate teaching methods to use.

One last set of possible researches appears well-justified. In education, now that there are several reasonably precise theories of human memory, it should be possible to investigate memory involvement in two areas. First, research should be implemented on the use of computer-assisted instruction (CAI) since educators have always been greatly

concerned with the question of what the most effective methods are for teaching children. Optimization of learning is the key goal. The second research area would be in developing assessment tools to investigate semantic memory, or how well some particular subject matter has been committed to memory. There is a lack of such instruments for differentiation between what facts students have learned and possible reorganization of semantic information with formation of entirely new retrieval schemes in the student's brain. Tasks designed within the framework of semantic memory models may actually measure this broader type of learning, providing a potentially valuable supplement, in terms of understanding learning, to currently applied examination procedures.

### The Future

In heading towards what many researchers and educators are referring to as the future learning society, the perceivable problems become momentous. Rapid social and technological changes have made the educational system as it currently exists in America virtually obsolete in terms of being able to keep up with the changes occurring. Just keeping abreast of what is necessary in a person's specialty is now a challenge to both energy and time. New strategies have become necessary, but, unfortunately, the education system in place does not seem to be rising to the challenge.

New methods of organization and revitalizing education are required. It has been established over twenty years ago (Tough, 1977) that 80+% of the adult population

participate in at least one learning project every year. The average American will change careers three times during his lifetime. As long ago as 1978, it was estimated that 40 million Americans were in a state of job or career transition (Arbeiter et al., 1978). It can only be worse in terms of number now.

Memory training may play a large role in the education in the future, primarily due to the need to absorb and be cognizant of so much more information in virtually all technical fields. To facilitate this, it must be recognized that such memory enhancement techniques involve skills that are teachable and can be learned by even students with low levels of ability. Studies such as this have demonstrated that such teaching can be effectively done in the classroom, impacting all the students at each level of ability, not limited to those that are "gifted" or substantially above average in pre-existing skills. The effectiveness of such instruction will depend on the teachers, who must be themselves taught in a rigorous fashion so that the essentials of conveying the information to others is clearly understood. There is also obviously a need for the creation of memory technique materials. The problem is that of ensuring the average person will be ready and able to cope with the changes and demands placed on him or her in the future, an idea only possible through the development of the ideas of life-long learning and continuous adult education. Memory training at a early stage may go a long way toward the preparation for dealing with those demands.

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APPENDICES

APPENDIX A  
SAMPLE TESTS

TEST 1: read the following list only once - try to remember both the word and the order of the listing.

LIBRARY  
PHOTOGRAPH  
AIRPLANE  
AUSTRALIA  
DUCKBILL  
STREAM  
LIGHTNING  
MOUNTAIN CLIMBER  
PINE TREE  
NOTEBOOK  
INTERCOM  
SEAT BELT  
ENCYCLOPEDIA  
CALCULATOR  
AFTERLIFE  
BALLOON  
CHIMPANZEE  
HALLOWEEN  
SNOW BOARD  
CAMPFIRE

TEST 2: You have 60 seconds to remember this list of words so that the appropriate words are in the correct order with their number.

1. EARTH
2. calendar
3. notepad
4. spider
5. China
6. opal
7. blimp
8. mummy
9. glove
10. shuttle
11. reservoir
12. movie star
13. eye dropper
14. zipper
15. license
16. Christmas
17. shovel
18. post hole
19. penguin
20. constellation

## TEST #3: NUMBERS

Look at the four 15-digit numbers below. Time available = 2 minutes, so do not spend more than thirty seconds on any one number. The numbers need to be in order when you are finished.

1. 774839582019504
2. 111902954038574
3. 4593485029361218
4. 6029195647058675

## TEST #4: NAMES AND FACES

Look at the ten faces on the page for two minutes. You are trying to remember clearly which name goes with which set of features.

1. Berry Black
2. Johan Wickel
3. Connie Bear
4. Sherri Walker
5. Beverly Coinage
6. Taylor Greenspan
7. Christy Brown
8. Neil Chang
9. Pat "the Weasel" Hofferdorf
10. "Smiley"  
Ben Cartwrong

## TEST #5: NUMBER RESPONSE

MEMORIZE THIS LIST OF TEN LOCATIONS AND THEIR TELEPHONE NUMBERS. YOU HAVE TWO MINUTES TO REMEMBER AS MANY AS YOU CAN.

local dog-catcher	238-5683
local doctor	593-0073
grocery store	730-8582
local gymnasium	451-0569
plumbing store	634-8731
dry-cleaning store	812-0454
bookstore in the mall	357-1587
dentist	361-4489
local bank manager	441-3906
local stock broker	251-8020

## TEST #6: DATES

Listed below are ten important semi-historical dates (mostly fictional). You have two minutes to remember them, along with the associated events.

1. 1384 earthquake wipes out Tylerville
2. 619 BC Jones boys take over kingdom of Sarcis
3. 1929 83 dive from windows as Stock Market crashes
4. 1103 Crusaders win battle of Little Rock River
5. 1641 burning at stake of 3 witches in Vienna
6. 1763 King Juan V of Spain marries
7. 333 BC Persians conquer entire middle East
8. 1982 first Mars rock smashes into Antarctica
9. 1493 Mikael Romanov discovers New Scotland
10. 772 AD Boris of Spotsguard beats Huns

APPENDIX B  
BASIC DATA QUESTIONNAIRE

MEMORY WORKSHOP

BASIC DATA

NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

PHONE: \_\_\_\_\_

AGE: \_\_\_\_\_ SEX: M F

YEARS OF EDUCATION: \_\_\_\_\_

MAJOR (IF APPLICABLE): \_\_\_\_\_

NAME OF SCHOOL: \_\_\_\_\_

OCCUPATION: \_\_\_\_\_

AMOUNT OF TIME SPENT READING DAILY: \_\_\_\_\_

CURRENT MEMORY ABILITY:

EXCELLENT      GOOD      FAIR      POOR

REASON(S) FOR TAKING WORKSHOP:

\_\_\_\_\_

\_\_\_\_\_

APPENDIX C  
SKILLS INSTRUMENT

**Directions and Answer Sheet for SKILLS  
(Set 1)**

**First:** Read the six scenes dealing with real-life learning situations. Select **four** that make sense to you as situations that apply to you.

**Second:** After you have selected four scenes, turn to the pages for these scenes that describe various learning strategies that you might use in these situations. For each scene, select the 5 learning strategies that you would **Definitely Use**, 5 that you might **Possibly Use**, and 5 that you would **Not Likely Use**. Enter the number for each of these 5 items in the proper box below.

Auto Insurance	Burial Customs	Local History	Pet Care	Job Regulations	Cholesterol Level
Definitely Use	Definitely Use	Definitely Use	Definitely Use	Definitely Use	Definitely Use
Possibly Use	Possibly Use	Possibly Use	Possibly Use	Possibly Use	Possibly Use
Not Likely Use	Not Likely Use	Not Likely Use	Not Likely Use	Not Likely Use	Not Likely Use

## Real-Life Learning Situations (Set 1)

### AUTO INSURANCE

Your insurance company has better rates on auto insurance and better customer service than any company you have ever found. However, they believe that informed drivers are good drivers and have just started giving tests about driving laws and practices to everyone who wants to renew their insurance policy with the company. **How likely are you to use the following learning strategies in preparing for the test?**

### BURIAL CUSTOMS

Funeral arrangements are being made for your best friend's father. You want to attend the funeral services. Because your friend is of a distinctively different culture, you are afraid you will not know how to act and thus will offend your friend's family. **How likely are you to use the following strategies in learning what you need to know about this friend's customs related to death and burial?**

### LOCAL HISTORY

You have gotten a book on the history of the place where you live because you want to be able to tell friends and visitors interesting facts and stories about your town. **How likely are you to use the following strategies to learn everything you want to learn and remember about the history of your area?**

### PET CARE

You have agreed to watch your friends' pet during their extended vacation. Your friends love their pet. The pet unexpectedly begins to act very strangely, and you do not know what to do. **How likely are you to use the following strategies in finding out how to care for the pet?**

### JOB REGULATIONS

Some of your fellow workers start talking about the new regulations that will affect everybody with your job or position. You hear that copies of the regulations are in a big manual in the library and in the court house. **How likely are you to use the following learning strategies in finding out what the regulations are and what you need to do to keep your job?**

### CHOLESTEROL LEVEL

You have recently visited the doctor and discovered that your cholesterol level is well above a healthy level. You have been advised to regulate this condition through diet. You are now left with the task of learning about proper nutrition and of changing your eating habits. Your next checkup is in six weeks. **How likely are you to use the following strategies in learning what you need to do in order to change your eating habits?**

## AUTO INSURANCE

Your insurance company has better rates on auto insurance and better customer service than any company you have ever found. However, they believe that informed drivers are good drivers and have just started giving tests about driving laws and practices to everyone who wants to renew their insurance policy with the company. How likely are you to use the following learning strategies in preparing for the test?

Directions: Select the 5 strategies from the following list of 15 that you feel you would definitely use and place the number of these strategies on the lines in the *Definitely Use* box of the answer sheet. Select 5 other strategies that you might possibly use and place the number of these strategies in the *Possibly Use* box of the answer sheet. Select 5 other strategies that you would least likely use and place the number of these strategies on the lines in the *Not Likely Use* box of the answer sheet.

1. Starting the learning by looking at materials to determine what is most important to study
2. Making up your mind to study the testing information because you want to renew your policy
3. Asking your local insurance agent whether the company has prepared material to help people study for the test
4. Thinking about the advantages and disadvantages of continuing with the insurance company
5. Reminding yourself periodically that you do not want to have to change your insurance company
6. Checking out the correct practice with an expert if you disagree with answers suggested in study material
7. Stopping to ask yourself questions while studying to see if you are remembering specific information
8. Studying confidently for the test because you are sure you will pass if you do study
9. Developing visual images in your mind, such as picturing a page in the manual, to help you remember
10. Finding another person taking the test who can quiz you over the material
11. Making a list of the things you have trouble remembering in order to review them often before the test
12. Asking yourself whether there might be a better way of studying for the test
13. Thinking about past experiences you have had taking exams so you can avoid difficulties on this test
14. Deciding to stop studying when you feel you are prepared for the exam
15. Thinking through the difference between things you learn that may help you pass the test and those that may actually improve your driving

## BURIAL CUSTOMS

Funeral arrangements are being made for your best friend's father. You want to attend the funeral services. Because your friend is of a distinctively different culture, you are afraid you will not know how to act and thus will offend your friend's family. How likely are you to use the following strategies in learning what you need to know about this friend's customs related to death and burial?

Directions: Select the 5 strategies from the following list of 15 that you feel you would definitely use and place the number of these strategies on the lines in the *Definitely Use* box of the answer sheet. Select 5 other strategies that you might possibly use and place the number of these strategies in the *Possibly Use* box of the answer sheet. Select 5 other strategies that you would least likely use and place the number of these strategies on the lines in the *Not Likely Use* box of the answer sheet.

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| <ol style="list-style-type: none"> <li>1. Thinking about what might interfere with your attempts to learn about the customs of other people</li> <li>2. Resolving to study about your friend's burial customs because you want to be of help</li> <li>3. Calling those arranging the burial to see if they can offer some advice on appropriate cultural practices</li> <li>4. Determining whether the funeral practices that you are familiar with are appropriate for your friend's culture</li> <li>5. Recognizing that you will need to learn about these funeral customs to bring comfort to your friend</li> <li>6. Checking the behavior you decide is appropriate with a person knowledgeable about your friend's culture</li> <li>7. Reviewing your learning progress to see if your plans for learning are working</li> <li>8. Feeling confident that you can learn enough in the next few days to understand your friend's burial customs</li> </ol> | <ol style="list-style-type: none"> <li>9. Thinking through what you will do at the funeral so you will not fall into old habits</li> <li>10. Asking other friends whether they have had any experience with burial customs in this or other cultures</li> <li>11. Jotting down any unfamiliar names or customs so you can refer to them when paying your respects</li> <li>12. Thinking of other ways you can pay your respects to your friend's family</li> <li>13. Recalling other things you know about the customs of your friend's family to see if what you are learning fits in</li> <li>14. Revising your plan for learning if you feel you are not gaining insight into that culture's burial customs</li> <li>15. Testing out in your mind different practices to see if they are appropriate</li> </ol> |
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## LOCAL HISTORY

You have gotten a book on the history of the place where you live because you want to be able to tell friends and visitors interesting facts and stories about your town. How likely are you to use the following strategies to learn everything you want to learn and remember about the history of your area?

Directions: Select the 5 strategies from the following list of 15 that you feel you would definitely use and place the number of these strategies on the lines in the *Definitely Use* box of the answer sheet. Select 5 other strategies that you might possibly use and place the number of these strategies in the *Possibly Use* box of the answer sheet. Select 5 other strategies that you would least likely use and place the number of these strategies on the lines in the *Not Likely Use* box of the answer sheet.

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| <ol style="list-style-type: none"> <li>1. Thinking through what kind of stories or facts you want to learn</li> <li>2. Setting aside a specific time when you are going to study local history</li> <li>3. Checking the computerized catalogue at a library to see if there are other history books on the area</li> <li>4. Looking for the complete story behind popular interpretations of local history</li> <li>5. Stopping to think about how nice it will be to have such stories to tell friends and visitors</li> <li>6. Checking to see if this book and author are trustworthy sources for information about your town</li> <li>7. Comparing your understanding of how history generally develops with your local history to determine what you need to learn</li> <li>8. Stopping to reassure yourself that you can find plenty of interesting facts about your town</li> </ol> | <ol style="list-style-type: none"> <li>9. Painting a mental picture of the area as a setting for the story you want to remember</li> <li>10. Discussing your ideas with people who have lived a long time in the area to see if their insights are different from what you are learning</li> <li>11. Jotting down notes about the major points you want to remember</li> <li>12. Asking yourself whether you have stories that would be of interest to the various types of visitors you expect</li> <li>13. Remembering what it might have been like to live in your area at the turn of the century to check if these stories have been glorified over time</li> <li>14. Deciding when the information you have gathered is adequate for telling interesting stories</li> <li>15. Accepting the author's account of many past events but continuing to look for information that may better explain interpretations given by the author</li> </ol> |
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## PET CARE

You have agreed to watch your friends' pet during their extended vacation. Your friends love their pet. The pet unexpectedly begins to act very strangely, and you do not know what to do. How likely are you to use the following strategies in finding out how to care for the pet?

**Directions:** Select the 5 strategies from the following list of 15 that you feel you would definitely use, and place the number of these strategies on the lines in the *Definitely Use* box of the answer sheet. Select 5 other strategies that you might possibly use and place the number of these strategies in the *Possibly Use* box of the answer sheet. Select 5 other strategies that you would least likely use and place the number of these strategies on the lines in the *Not Likely Use* box of the answer sheet.

1. Identifying what you need to know in this unexpected situation to care for the pet
2. Admitting to yourself that you need to begin immediately paying close attention to the pet's behavior
3. Beginning to form a list of resources you might use to check the pet's behavior
4. Questioning whether there are things other than illness that could be causing the pet's strange behavior
5. Reminding yourself of how hard it would be to tell your friends that something happened to their pet
6. Checking with several other people who should be knowledgeable about this type of pet to see if all give similar advice
7. Checking to see if what you are finding out is helping you understand the pet's behavior
8. Reflecting on your experience with other pets to reassure yourself that you can take control of this matter
9. Watching for patterns in the pet's behavior so you will remember exactly how the pet is acting
10. Discussing the pet's behavior with someone who has a similar type of pet
11. Writing down changes in the pet's behavior so you will be able to describe them to others
12. Checking whether the pet's behavior could be due to your friend's absence
13. Recalling similar experiences with other pets to figure out what to look for
14. Deciding if you have enough information to make a decision to begin to care for the pet
15. Testing one of the suggestions you have gotten to see if it changes the pet's strange behavior

## JOB REGULATIONS

Some of your fellow workers start talking about the new regulations that will affect everybody with your job or position. You hear that copies of the regulations are in a big manual in the library and in the court house. How likely are you to use the following learning strategies in finding out what the regulations are and what you need to do to keep your job?

Directions: Select the 5 strategies from the following list of 15 that you feel you would definitely use and place the number of these strategies on the lines in the *Definitely Use* box of the answer sheet. Select 5 other strategies that you might possibly use and place the number of these strategies in the *Possibly Use* box of the answer sheet. Select 5 other strategies that you would least likely use and place the number of these strategies on the lines in the *Not Likely Use* box of the answer sheet.

1. Thinking through what is important to know about these new regulations in order to decide what needs to be learned
2. Setting aside an evening to visit the library to review the new regulations
3. Finding out if there is an 800 number where you can get answers to specific questions you have
4. Thinking through how the new regulations will actually change the way you do your job
5. Reminding yourself of the difficulties you may avoid by learning the new regulations
6. Deciding to look through the regulations themselves.
7. Comparing your understanding of the new regulations with commonly accepted practices on the job
8. Reminding yourself that you have always been able to keep up with new regulations for a job
9. Remembering the new regulations by organizing them according to the daily routine you follow at work
10. Checking with your supervisor and fellow workers to find out if they have similar ideas about the new regulations
11. Placing your list of key points in a convenient place so they will remind you of what you have to do
12. Thinking of various ways that you can use the new regulations to improve your job situation
13. Reflecting on past experiences at the courthouse or library so you can avoid wasting time
14. Asking yourself if there are any parts of the job regulations that still confuse you
15. Beginning to test some of the new procedures on the job to see if they are going to work for you

## CHOLESTEROL LEVEL

You have recently visited the doctor and discovered that your cholesterol level is well above a healthy level. You have been advised to regulate this condition through diet. You are now left with the task of learning about proper nutrition and of changing your eating habits. Your next checkup is in six weeks. How likely are you to use the following strategies in learning what you need to do in order to change your eating habits?

**Directions:** Select the 5 strategies from the following list of 15 that you feel you would definitely use and place the number of these strategies on the lines in the *Definitely Use* box of the answer sheet. Select 5 other strategies that you might possibly use and place the number of these strategies in the *Possibly Use* box of the answer sheet. Select 5 other strategies that you would least likely use and place the number of these strategies on the lines in the *Not Likely Use* box of the answer sheet.

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| <ol style="list-style-type: none"> <li>1. Making a plan that will help you learn enough about cholesterol and eating habits</li> <li>2. Focussing on learning about good diet practices instead of just worrying</li> <li>3. Getting a book that has recipes for a low cholesterol diet and information on cholesterol from your local book store</li> <li>4. Checking for other ways of lowering your cholesterol besides changing your diet</li> <li>5. Reminding yourself how nice it would be to reduce your cholesterol significantly by your next visit to the doctor</li> <li>6. Setting up an appointment with a dietitian to help you make sense of all the information you have been receiving and hearing about</li> <li>7. Checking to see if what you are learning is actually helping you solve your cholesterol problems</li> <li>8. Reminding yourself you have been able to learn new health practices before</li> </ol> | <ol style="list-style-type: none"> <li>9. Organizing high cholesterol foods into certain categories to help remember what foods to avoid</li> <li>10. Calling several friends who have had high cholesterol to discuss what lifestyle changes worked best for them</li> <li>11. Placing a cholesterol information sheet on your refrigerator as a reminder to change your eating habits</li> <li>12. Studying various eating habits so you can set priorities on which changes will have the most impact on lowering your cholesterol</li> <li>13. Reflecting on previous experiences you have had with diets to know what techniques and attitudes work for you</li> <li>14. Revising your learning method if you find you are becoming confused</li> <li>15. Deciding to implement a specific low-cholesterol diet with the understanding that you will periodically check its effectiveness.</li> </ol> |
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**Location of Learning Strategies  
in SKILLS**

Learning Strategy	Item Number
<b>Metacognition</b>	
Planning	1
Monitoring	7
Adjusting	14
<b>Metamotivation</b>	
Attention	2
Reward/Enjoyment	5
Confidence	8
<b>Memory</b>	
Organization	9
External Aids	11
Memory Application	13
<b>Critical Thinking</b>	
Test Assumptions	4
Generate Alternatives	12
Conditional Acceptance	15
<b>Resource Management</b>	
Identification of Resources	3
Critical Use of Resources	6
Use of Human Resources	10

## Learning Strategy Scores on SKILLS

Name:

COMPANY: MSUC

**Note:** Total scores for each section may range from 12 to 36. Individual component scores may range from 4 to 12. High scores are strategies you use, and low scores are for those you do not use.

### **Metacognition: Total--22.00**

(Knowing about and directing one's own thinking and learning process)

**8.00--Planning:** analyzing the best way for one's self to proceed with a specific learning task. Examples: follow own learning style, skim or overview, determine purpose or focus, plan learning process before beginning

**6.00--Monitoring:** assessing how one is proceeding through a learning project. Examples: review plans, check if on task, compare to accepted standard or model

**8.00--Adjusting:** directing and improving one's learning processes. Examples: evaluate seek feedback, change approach, decide when done

### **Metamotivation: Total--23.00**

(Awareness of and control over factors that energize and direct (motivate) our learning)

**10.00--Attention:** focusing on material to be learned. Examples: set aside time for learning, resolve to learn, avoid distractions

**6.00--Reward/Enjoyment:** anticipating or recognizing the value to one's self of learning specific material and having fun or satisfaction with the learning activity. Examples: recognizing learning as relevant or useful or potential problems of not knowing, important or worthwhile, imagine fun, good feeling, satisfaction, or pride

**7.00--Confidence:** believing that one can complete the learning task successfully. Examples: feel confident or reassured, remind self of past success, get support from others

### **Memory: Total--23.00**

(The storage, retention, and retrieval of knowledge)

**4.00--Organization:** structuring or processing information so that material will be better stored, retained, and retrieved. Examples: image, elaborate or translate, chunk, pattern, summarize, or fit together, memory devices

**10.00--External Aids:** using external aids to reinforce memory. Examples: write down or list, put on display, ask another to remind

**9.00--Memory Application:** using remembrances, mental images, or other memories to facilitate planning or problem solving. Examples: to avoid mistakes, to know what to expect, to select methods, to provide background information

### **Critical Thinking: Total--20.00**

(Reflective thinking process utilizing higher order thinking skills in order to improve learning)

**6.00--Test Assumptions:** recognize and evaluate in relation to learning situation; especially evaluating the specifics and the generalizability within a situation. Examples: examine accuracy of assumptions, identify relationships, spot inconsistencies, critical acceptance, questioning value sets, testing appropriateness

**7.00--Generate Alternatives:** hypothesize but ground options within a given situation. Examples: brainstorm or envision future, hypothesize, rank order, identify other solutions

**7.00--Conditional Acceptance:** reflective and tentative maintenance of principles. Examples: question simplistic answers, monitor or evaluate results, predict consequences

### **Resource Management: Total--32.00**

(The process of identification, evaluation, and use of resources relevant to the learning task)

**12.00--Identification:** knowing how to locate and use the best source of information. Examples: modern information sources, print sources, people or models, professionals or agencies

**10.00--Critical Use:** using appropriate rather than available resources while recognizing their limitations. Examples: contact expert or outsider, check second source, observe or ask to check bias

**10.00--Human Resources:** integrating others into the social and political processes of learning. Examples: dialogue or discuss, check opinions, listen, get support from or network with others

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