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Effects of Adjunct Postquestions and Attitude Toward Memory in Increasing Textual Retention in Older Adults

Joan H. Woods

A Thesis

in

the Department

of

Education

Presented in Partial Fulfillment of the Requirements
for the Degree of Master of Arts at
Concordia University
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ABSTRACT

Effects of Adjunct Postquestions and Attitude Toward Memory in Increasing Textual Retention in Older Adults

Joan H. Woods

This study was designed within the framework of a contextual, life-span developmental approach to learning. Its purpose was to investigate textual retention through the use of adjunct conceptual postquestions as an instructional strategy, and a statement stressing the effects of attitude on the ability to remember. Twenty-three male and nineteen female university students, whose minimum age was 60, formed the three treatment conditions; one received the strategy plus attitude statement, one received only the strategy, and one acted as a read only control. Intentional and incidental idea units, in a naturalistic setting, were used to measure whether the instructional strategy would increase mathemagenic activity and depth of processing. The design employed two time intervals. Metamemory, the ability to assess the contents of one's memory, was also studied for its ability to stimulate the use of mnemonic strategies in textual retention. Analysis indicated that the strategy group receiving the attitude statement performed significantly better than the non-strategy group on the recall of intentional idea units. No significant differences were found between the two strategy groups on intentional learning, or between the three groups on the recall of incidental idea units. The use of the MIA to predict textual retention from subjects' assessment of their metamemory

was not found to be effective. It was suggested that a more complex assessment of the constructs might be needed for a higher order learning task. The results of this experiment lends support to the concept of instructional design models that consider the interaction of learners' characteristics, materials and type of task, and performance criteria.

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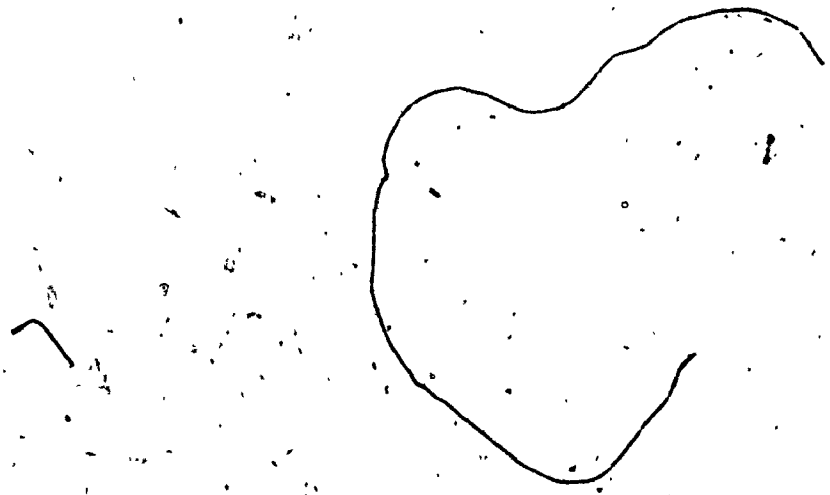

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CHAPTER 1

Introduction

The past two decades have seen an explosion in psychological, medical and educational literature relating to life-span development. One need not look further than the daily newspapers to find statistics on the increasing number of older adults that have generated this interest.

From the point of view of the older adult, a need for further education has been sparked by such concerns as a desire for a second career, an increase in leisure time, and changes in the laws regarding mandatory retirement which have necessitated keeping abreast of new technologies. Medical advances have lengthened the life span in both quantitative and qualitative terms, and older citizens have become more vocal in their desire to take advantage of either missed educational opportunities, or a continuation of lifelong learning.

Until recently the picture that has emerged from research on learning and memory has been generally pessimistic in terms of older adults' performance on retention tasks. These results, however, came mainly from laboratory studies using material that was not meaningful to older adults, that considered speed in recall as a dependent variable, that asked for verbatim rather than gist recall, and did not allow for review before testing (Botwinick, 1978; Craik, 1977). These elements are not found outside of contrived situations, and their generalizability to the actual processing of meaningful text is questionable (Taub, 1980).

The design of these types of laboratory studies on memory emanated from the theoretical base of behaviorist psychology and, to a lesser extent, from the cognitivists who followed (Dixon, 1982). Within the past ten years, and particularly with regard to adult development as a lifelong process, there has been a further shift to a contextual orientation to memory research. In this model the adult's present environment and past experiences are seen to be interrelated with the processing of new information (Hultsch & Dixon, 1984; Hultsch & Pentz, 1980; Jenkins, 1974). It is within this framework that the present study was designed because it was felt to be the most relevant for researching older adults' ability to encode and retrieve educational textual materials.

It is Botwinick's (1978) view that if one does not learn well, one has little to recall; there is no evidence of learning having taken place. Much of what was thought to be a deficit in cognitive processes is now seen as a problem in adapting to a task, and demonstrating knowledge. When research in presenting educational materials is designed with older learners' characteristics in mind (i.e., the pace is appropriate, instructions are explicit, and the task is meaningful), Botwinick speculates that this population may demonstrate cognitive capacities that were not recognized before.

The use of a contextual approach in memory research suggests that multiple factors can affect performance (Jenkins, 1979). The present study was designed, therefore, to investigate the following variables. First, the activities that learners actually engage in when they are studying textual material. The research of Rothkopf (1965, 1970, 1976)

has suggested that learners use idiosyncratic behaviors to ascertain the salient parts of to-be-learned material. He has termed these behaviors "mathemagenic activities", and noted that their control could be used to direct instruction. The use of questions inserted at intervals (adjunct) throughout a text is a method used successfully by Rothkopf to stimulate such activity. In the present study the use of adjunct postquestions of a conceptual nature were used with an educational text because researchers utilizing age-related textual learning have regularly proposed that older adults have difficulty in organizing and processing information to a sufficient depth (Botwinick, 1978; Craik, 1977; Dixon, Simon, Nowak, & Hultsch, 1982; Glynn & Muth, 1979). Since learning tends to be directed toward long term retention, an instructional strategy employed to promote a more thorough analysis of the subject matter would appear to be of more benefit to the learner.

Second, it is necessary to measure the amount of retention that learners can demonstrate if the effectiveness of a learning strategy is to be analyzed. In this measurement the gist recall of ideas that have been questioned (intentional learning) and additional unquestioned ideas that learners have acquired (incidental learning) is a more naturalistic method of determining what has been retained from the stimulus material. If there are differences in the amount of intentional information that is retained between a treatment group receiving adjunct postquestions and a control group without the questions, particularly over a delay interval, these differences may be partly attributable to the use of adjunct postquestions as a learning strategy. The promotion of incidental learning is important in

contextual cognitive theory because of the relationship that has been found between the older adult's extensive base of stored data and the acquisition of new information (Dixon, 1982; Lachman and Lachman, 1980).

Third, the concept of metamemory, which is the knowledge and awareness one has about one's memory in terms of storing and retrieving information (Flavell, 1974; Flavell & Wellman, 1977). The present study was interested in what older adults who have returned to an educational environment think about their memories, and whether a reinforcing statement about the necessity of maintaining a positive attitude toward memory function as an enduring ability might enhance performance. One method of obtaining subjective information about metamemory in the older adult was thought to be the Metamemory in Adulthood (MIA) instrument (Dixon & Hultsch, 1984). This psychometrically valid instrument was developed to measure eight dimensions felt to be descriptive of metamemory and its relationship to the retention of text. Knowledge of the ways in which metacognition and metamemory guide the older adult's learning processes can improve the ways in which learning aids are presented. Bovy (1981) asserts that methods of high lighting the to-be-learned materials in ways that facilitate integration of newly acquired data with prior related knowledge is a strategy which instructional developers have neglected in the past.

More research has been called for (Bovy, 1981; Cavanaugh & Perlmutter, 1982; Hultsch & Dixon, 1984) that will simultaneously: (a) determine how instructional developers can design aids to ensure better organization and deeper processing of educational materials; (b) assess

how older adults' knowledge and attitude toward their memory may affect recall; (c) develop models of learning which will take into consideration the mediation of person and task variables as they interact in cognitive processing. The design of the present study attempted to incorporate the preceding suggestions by manipulating the independent variable (adjunct postquestions) at two levels. It included three groups of subjects, two of whom received adjunct conceptual postquestions (strategy) embedded in an educational text, plus one read only control. One of the strategy groups received, in addition, a reinforcing statement concerning memory function. This design generated the following research questions, using intentional and incidental learning as the dependent measures.

1. Will the presentation of adjunct conceptual postquestions as an instructional strategy increase the retention of intentional and incidental ideas from an educational text?

2. If two treatment groups receive the same instructional strategy, will the addition of a positive statement concerning memory function, presented to one group, enhance performance for that group?

3. Is the prediction of metamemory and its relationship to textual retention, as measured by the MIA, similar in two older adult age cohorts?

Statement of the Problem

Theories of learning and memory have changed their orientation, but the results from the studies these earlier theories generated, particularly with regard to comparing different age cohorts of adults on information retrieval, have not been conducive to the development of

educational programs for older adults.

Research in the field, in an actual educational setting is proposed by Wass & Olejnik (1983) as a method of determining the salient factors that should be considered in developing materials that will benefit the training and education of older adults. In particular, they question the educational significance of the differences that may be observed between age cohorts. While research results may have statistical significance, they may not have a practical significance in terms of what older adults want and need to learn.

The interest of the present study was, therefore, in the investigation of within-group differences in a population of older adults in terms of extending, to this population, studies using adjunct post-questions. In addition, the effects of the attitude dimension of metamemory were studied because of Dixon's (1982) suggestion that non-cognitive factors may be partially responsible for poorer performance on retention with older adults. Naturalistic material, gist recall and unlimited time in a classroom atmosphere with which subjects were familiar were combined with a standardized reading comprehension test to provide a context within which the retention of an educational text might be examined.

CHAPTER 2

Literature Review

Theoretical Perspectives

In terms of life-span developmental psychology there has been a change in the theoretical perspectives from which some researchers are looking at the encoding and retrieval aspects of memory. Hultsch & Pentz (1980) and Overton & Reese (1973) state that descriptions of learning and remembering are based on the root model from which these two constructs are derived, and research results necessarily reflect the bias of the model.

Briefly, the first of these is the associative or mechanistic model which regards the individual as passive and reactive. The metaphor of a machine (Overton & Reese, 1973) led to a cause and effect perspective used in terms of antecedent-consequent relationships. Learning was seen to be the result of stimulus-response bonds, and retrieval as the reverse process of emitting the needed response when the appropriate stimulus was presented. Forgetting was thought to be caused by such processes as interference or decay which resulted in a weakening of the associative links between learning and remembering.

Craik (1977) describes the second model as information processing and multistore in which the organism actively transforms information from brief, peripheral (sensory) memory to working (short term) memory to secondary (long term) memory, characterized by the meaningful organization and relationship of new information to what is already known. Wingfield (1979) suggests that practices such as attention to stimuli,

rehearsal and analysis are the control processes for this model.

As mentioned previously, the third model for studying learning and memory, contextual, was chosen for the present study. In 1932 Bartlett attempted to explain the retention of meaningful text through a series of studies which suggested that our concepts or schemata of the world are based on past experience which is integrated with new information when learning takes place. In Bartlett's (1932) view, memory is a voluntary process combining the reconstruction and elaboration of the originally acquired information.

Forty years later, Bartlett's work was revived and termed contextualism by Jenkins (1974) who stated that experience was composed of events, each of which had a quality which was its total meaning. This quality was the result of an interaction between the individual and the context of the event. As an example, when a person hears a sentence, its meaning, for that person, is within the context of the spoken words depending on intonation, the relationship between speaker and listener, and past experience. The meaning and, therefore, the memory may not be the same for other listeners at the same time and place. Jenkins (1974, p. 786) considers that "what memory is depends on context".

As mentioned previously, the generative model determines the type of tasks which are used to measure performance, and the nature of the conclusions drawn from them. The associative approach, due to its theoretical base, is responsible for much of the pessimistic view that has surrounded memory and aging. It viewed older adults as being more subject to interference, which was thought to be caused by physiological degeneration due to the organism's aging. The passive

individual had no control over any learning processes, affected as s/he was by a biological decline (Schaie, 1974).

Information processing models consider the individual to be more actively in control of learning and recall, although they regard these two processes as separate from one another. Within the context of the organizational processes involved in encoding and retrieval there has been empirical support for an age deficiency in older adults' memory, wherein these individuals seem to have a deficit in accessing information that has already been stored (Craik, 1977; Hultsch, 1974, 1975; Lachman, Lachman, & Thronesbery, 1979; Perlmutter, 1978). Research has been concerned with determining the locus of this deficit which, in contrast to the associative approach, is seen to be modifiable (Hultsch & Pentz, 1980).

For the contextualist, learning and memory are not thought of as being composed of associative links, or as storage structures and control processes, but rather stress the kinds of events experienced by the individual within the total context of the event. Where learning is seen as the formation of new associations, Craik (1977) suggests that more appropriate tasks for older learners (e.g., meaningful text and gist recall) would probably produce performances more similar to those of younger adults.

Ecological and external validity are methodological issues in a contextual framework because they address problems that could normally occur in the everyday activities of the target population (Bronfenbrenner, 1977; Hultsch & Pentz, 1980). It is for this reason that ecologically valid textual materials in a naturalistic setting are

suggested as a better way to assess the memory capabilities of older adults, rather than nonsense syllables and laboratory tasks that have no meaning to the subject (Kintsch, 1977).

Schema theory has been proposed as an explanation for the method by which textual material is encoded and retained. According to this theory, (Brooks, Dansereau, Spurlin & Holley, 1983) when learners process information they use schemata and subschemata in a hierarchical fashion. These researchers define schema as a generalized representation in memory of thoughts, objects or procedures which become more specific when a schema is activated. A face schema is cited as an example wherein the viewer fills in the individual characteristics of eyes, ears, nose and mouth when a particular person is seen or remembered. Subschemata are available (e.g., eyes) which might include color, shape and size.

One of the ways in which schemata are thought to operate is in the arrangement of "boundary conditions which set the stage" in terms of the data an individual will encode (Bransford, McCarrel, Franks, & Nitschi, 1977, pg. 434). Schemata (Kintsch, 1977; Norman, 1982), and levels of processing (Craik & Tulving, 1975) are examples of such boundaries that are related to text processing.

The notion of a schema, as proposed by Kintsch (1977, p. 374) is an "organized representation of a person's knowledge about some concept, action, event, or a larger unit of knowledge". For example, a boundary can be seen in the case of an individual who is familiar with the organization of particular texts such as research journals. Kintsch suggests that comprehension of their contents will be facilitated by an

awareness of the structure, subheadings, and selection of information that will appear in each section. In other words, a schema is available in which to process the text, and comprehension is easier for an experienced researcher than for a novice who has yet to develop that particular schema. Schemata can be used for inference (i.e., lettuce is a vegetable, vegetables are plants, therefore lettuce is a plant), or for reconstruction wherein a person will remember the theme or gist of a text, and will add details at the time of recall.

Norman (1982) considers a schema boundary to be a more advanced and organized level of knowledge than the simple structure of a semantic network which he describes as an individual's general store of knowledge. It is integrated and relevant to a particular category, such as a schema about books or microwave cooking, and contains both knowledge and rules for use of that knowledge.

Studies by Craik & Tulving (1975) suggest that another boundary on learning is the depth of encoding, which is determined by the context of the to-be-learned material. They consider "depth" to be more involvement in terms of organizing information and relating it to what is already known (semantic memory). Craik and Tulving contrived experiments in which subjects processed words to different levels as a function of the type of question they were asked about the words. Results showed that it was the nature of the task and the kinds of actions that were performed on the items that determined recall performance, rather than the intention to learn or the amount of effort expended. Retention appears to increase when encoding can be placed in context with a subject's past learning or world knowledge. Craik &

Tulving suggest that this occurs because retrieval cues use schemata from semantic memory to reconstruct the original information. They summarize their findings with the observation that materials are remembered in terms of what learners did by way of encoding at the time of acquisition, not necessarily because they were given instructions to "learn".

Encoding will not take place, however, if the learner's attention is not focused on the material. Bovy (1981) stresses that insuring the learner's attending behaviors is a critical component of instructional design. Bovy cites the research of Neisser (1976) who noted that individuals' schemata will direct their attention to one kind of information rather than another, and therefore, perception and encoding will vary among individuals. Since gaining the learner's attention is prerequisite to attending to the to-be-learned material, Bovy contends that more research needs to be directed toward the kinds of instructional support that is given to learners.

Dixon (1982) proposes that memory is not a segment or a thing, nor can it be cut off from other cognitive processes within an individual. As context changes, so also does memory and the very nature of the contextual perspective, based as it is on individual differences, leads to a multidimensional concept of cognitive processes. Memory and its many attributes can be thought of as a system within which the individual functions according to such influences as past experience, capacity to learn, knowledge and use of learning strategies, and motivation. Research in the most effective use of instructional materials should be designed to take these interacting factors into

consideration (Bovy, 1981).

If instructional materials for older learners are to be remembered, these materials must have relevance; if energy is to be spent on the task of remembering, the task must be meaningful. The intent of the present study was to investigate the ways in which the use of an instructional aid might facilitate retention of meaningful text through the development of relevant schemata and deeper depth of processing. In keeping within a contextual framework the attempt was made to integrate subjects' reading comprehension abilities, and their subjective knowledge and attitudes toward memory into the learning model through the use of naturalistic materials.

Overview - Metamemory

One of the interests in the present study was that of metamemory and its relationship to textual retention as an important variable in adult learning. The term metamemory was suggested by Flavell (1971) as the knowledge one has about one's own memory. When an individual has an awareness that some concepts are easier to recall than others, or that some items are on the verge of recall while others were known at one time, but are not now retrievable that individual is said to have metamemory. Flavell's reasoning was that what we know and think will determine the ways in which we perceive new situations, predict outcomes, and solve problems. He suggests that as an individual's mind develops and more information is known, changes will occur in the manner in which learning and remembering take place. Flavell has theorized that the use and development of memory is an adaptive function of the mind which takes place when the task of storing and

retrieving data is encountered. For example, when one makes a deliberate effort to memorize something, it is with the intention of retrieving that particular bit of information at some time in the future. The perception one has of one's ability to remember will affect the way in which information is encoded, and the way in which search and retrieval operations are carried out. Specifically, in the case of older adults, metamemorial knowledge may determine whether mnemonic strategies will even be attempted (Flavell, 1971).

Flavell & Wellman (1977) have seen metamemory as having two elements, the ability to assess items that are currently in memory (memory monitoring), and the various facts that one might know about memory in general (memory knowledge). An example of memory monitoring would be the ability to assess whether an item was stored in memory and could be recalled either instantly or after a search, while memory knowledge might be knowing that concrete nouns are easier to recall than abstract nouns.

Knowledge about one's metamemory influences memory performance, and feedback from memory performance should result in more effective knowledge about one's metamemory (Dixon, 1982). Part of the developmental nature of metamemory is seen to be a growing awareness of when and why one should intentionally attempt to remember something.

Early studies on metamemory were conducted with children, centering on how the spontaneous use of learning strategies develops, how the use of mnemonic strategy instructions affect memory performance, and how these variables interact as children encounter a variety of situations requiring problem solving (for reviews see Brown, 1978;

Flavell & Wellman, 1977; O'Sullivan, 1983). The results of many studies clearly showed a developmental increase in childrens' knowledge of their memory capabilities in terms of recognizing that an item had been seen before, predicting memory span, and knowing that a piece of information was in memory even if it could not be recalled at the moment.

Brown (1978) has dealt with metamemory as a subset of metacognitive processes (i.e., knowing about remembering is subsumed by knowing about knowing). She suggests that knowing that one does not know, and knowing what information one ought to have is an important part of intelligent problem solving that guides the learner in the use of relevant strategies. Included in the development of metacognitive knowledge is the knowledge that certain tasks are more or less difficult and that they require a "conscious executive control of the routines available to the system" (p. 79). Brown stresses the importance of the knowledge about one's own cognitions, rather than the cognitions themselves. This notion suggests that more research is needed into what older adults think about their memory, because of the relationship between what one knows about memory, and how one goes about memorizing.

Although the developmental nature of metamemory has been demonstrated, little research has been attempted to determine what children or adults do with this knowledge. It is difficult to ascertain whether poor performance is due to a lack of knowledge about learning strategies, or simply to a failure to use those strategies. Although it appears reasonable to presume that if an individual knows, for example, that rehearsal will improve performance s/he will use that strategy,

the possibility exists that it may not occur to the individual to do so.

Three such studies on the use of metamemorial knowledge are those of Cavanaugh & Borkowski (1979), Bruce & Cox (1983) and Hale (1983). Cavanaugh & Borkowski studied third grade children and found metamemory to be an important link in transferring learning strategies from one task to another. They concluded that metamemory's relationship to memory had a predictive capacity in the maintenance of that strategy. Bruce & Cox reported that self-perception of metamemory was a good predictor of efforts used by college undergraduates in the kind of logical structures that were used in spelling. Hale found a lack of metamemory knowledge in high school students' awareness of their expectations of forgetting prose passages and the effect of taking notes.

Metamemory: Ontogenetic Empirical Studies

Studies on metamemory utilizing age cohorts (between 20-80) have resulted in conflicting findings for a variety of tasks. In general, researchers have been interested in having subjects predict what they will be able to remember.

Perlmutter (1978) studied metamemory monitoring and knowledge and found no difference in young and old adults; Lachman et al. (1979) produced the same results in studying the accuracy and efficiency of the search duration of the monitoring element of metamemory. Both researchers used free recall with naturalistic memory situations. Perlmutter's subjects were given intentional and incidental verbal learning tasks and were asked to predict the number of words they could recall while Lachman et al. used response time as an indication

of confidence in fact retrieval from general knowledge questions.

While metamemory appeared to remain stable over time, the Perlmutter study revealed significant age differences (favoring younger adults) in word memory recall on both intentional and incidental tasks. Similar results were also achieved by Hultsch (1975) and Craik (1977) who suggested that older adults do not spontaneously use effective acquisition strategies.

Murphy, Sanders, Gabriesheski, & Schmitt (1981) were interested in memory monitoring and used serial recall of line drawings in what they determined was a more sensitive test of metamemorial awareness, operationalized by the amount of time spent ~~in studying, and~~ the accuracy of recall. They found that, although older adults accurately predicted the length of their memory span, they studied less, and underestimated the task difficulty. In a second experiment Murphy et al. instructed a different set of subjects to study longer, at which time recall scores were improved. Results of this experiment led to the conclusion, in contrast to Perlmutter (1978), that older adults might have a metamemory deficit in recall readiness that has to do with memory monitoring.

Using paired associate words measured by associate matching, Lovelace (1982) confirmed the Murphy et al. (1981) finding that there were no age differences in the accuracy of predicting what could be remembered, but older adults overestimated their performance. In contrast to Murphy et al. (1981), Bruce, Coyne & Botwinick (1982) found no age differences in the amount of time spontaneously alloted to studying and, therefore were in agreement with Lachman et al. (1979)

and Perlmutter (1978) that older adults did not suffer from a deficit in memory monitoring.

In the Perlmutter study the other component of metamemory, memory knowledge was derived from a questionnaire measuring subjects' thoughts about their memory. No significant age differences were found between age groups, and Perlmutter concluded that this area of metamemory remained intact over time. However, Bruce et al. (1982) found this research to be flawed because no test was made of the accuracy of the questionnaire responses. Their study compared age groups with respect to the memorization of high and low imagery and high and low frequency words. By comparing subjects' predictions of the number of words they could recall, and the number actually recalled, Bruce et al. were attempting to verify subjects' memory knowledge. They found that older adults overestimated their recall abilities and concluded that this type of metamemory declined with age.

Another facet of metamemory, that is, whether being in school provided more opportunities to practice mnemonic strategies was investigated by Zivian & Darjes (1983). Their work was based on that of Flavell & Wellman (1977) who suggested that school provided an environment for maintaining metamemory, and Hultsch (1974) who hypothesized that older adults' higher order learning skills might deteriorate due to lack of practice. Zivian & Darjes presented young and middle-aged university students, and middle-aged and elderly out of school subjects with randomly categorized word lists. They were asked to study and recall the lists and to indicate which mnemonic strategy had been used, and how useful it had been. Results showed that years of schooling, and

being in or out of school all related to strategy selection and use. These findings lend additional support to the multidimensional nature of metamemory and demonstrate that memory deficits in older adults are not due solely to aging.

In a critique of metamemory research Cavanaugh & Perlmutter (1982) have called for multiple assessment techniques that allow for a converging measurement of the variable of interest. A model for the kind of research they deem to be essential has been supplied by Jenkins (1979). He has advocated the simultaneous consideration of: (a) characteristics of the subjects, such as age, skills, purposes and knowledge; (b) the kinds of materials they are asked to remember, such as words, numbers or texts; (c) the orienting task which refers to the conditions under which they are asked to remember, such as intentional or incidental learning; (d) critical tasks which are the kinds of tasks given subjects which determine performance, such as recall or problem solving. Jenkins suggests that each of the above dimensions is related to the others, and that any interaction between two of the factors could be modified by a change in one of the others.

In his doctoral dissertation Dixon (1982) has appeared to avoid the criticisms of Cavanaugh & Perlmutter (1982). Dixon investigated age differences in metamemory within a contextual perspective. His interest was in the way in which knowledge of the growth, performance, limitations and capacities of an individual's memory might determine what plans and strategies would be best for a particular task. Much of the previous research, according to Dixon, has been an attempt to assess general metamemory abilities using tasks of poor ecological validity.

The use of text in studying metamemory resembles a more contextual measurement of memory than does word lists or nonsense syllables.

In addition, Dixon suggested that while scoring reliability was often reported in previous research, instrument reliability was not. To this end he designed a psychometric instrument to measure the multidimensional construct of metamemory in adulthood (MIA), and the relationship of metamemory to memory for text.

Development of the MIA

Dixon's (1982) review of metamemory literature identified eight dimensions of the construct which were then operationally defined. A content validation of 206 items, with at least 20 items for each of the dimensions, was carried out by experts. Since Dixon had decided a priori that 70% agreement between raters was necessary for an item's admission to the instrument, 151 of the original 206 items were included in the first draft (Form I). The dimensions fall, generally, into two categories, knowledge and affect. The knowledge component consists of the use of memory strategies, which refers to how an individual uses information about his/her abilities to remember in ways that will improve performance in a specific instance (STRATEGY); knowledge about the basic processes used in the task of remembering (TASK); prediction of personal performance on specific memory tasks (CAPACITY); and the degree to which the individual believes the ability to remember is subject to change (CHANGE). The affect component consists of the regularity with which the individual engages in cognitive pursuits which support memory (ACTIVITY); the ways in which the individual's emotional state is influenced by cognitive performance

(ANXIETY); the importance to the individual of maintaining a good memory and of doing well on tasks involving memory (ACHIEVEMENT); and the individual's sense of the amount of internal or external control that is available in the ability to remember (LOCUS).

Three separate experiments used 378 white, primarily female subjects from a small city in central Pennsylvania, who were paid a small sum for their participation. Using a five response Likert scale for each item, Form I was administered to 60 young (age 18-37) and 60 old (age 50-81) subjects. Following the experiment, coefficient α was calculated to determine the internal consistency of each of the subscales across age groups. A minimum coefficient of .65 was considered acceptable. Items which had a high correlation relative to their own subscales, but a low correlation relative to the other subscales were considered for inclusion in further development of the instrument. Additionally, the similarity of mean scores and standard deviations between groups was considered to be evidence of the consistency of the subscales. This analysis resulted in modifications leading to Form II which was administered to 36 young (age 21-39), 36 middle-aged (age 39-58) and 36 old (age 60-84) subjects. The same analysis was followed as for the first group resulting in further modifications which led to Form III. This group was composed of 50 young (21-39), 50 middle-aged (age 39-58) and 50 old (age 60-74) subjects.

Following the third trial, factor analysis was performed to examine each of the MIA items used in the preceeding experiments for its pattern of fit in the subscale to which it had been assigned, as well as the strength of its loading on the same subscale. Dixon

considered factor validity to be present "if each subscale could be identified as a factor in all three samples and if the preponderence of items associated with that subscale showed a strong pattern of loadings across the samples" (p.62). Items that showed weak patterns of loadings in all three samples were removed. The final form (Form IV) of the instrument, as administered in this study, contained 120 items whose subscales contained the following number of items: Strategy (18), Task (16), Capacity (17), Change (18), Activity (12), Anxiety (14), Achievement (16) and Locus (9). Further information from the Dixon (1982) study can be found in Appendix D.

For the three trials mentioned previously, different textual materials were used by each group to determine the relationship between their memory for text and the subscales of the MIA. The first group (using Form I of the MIA) used five short (180 word) texts taken from newspaper articles. Retention was tested at an immediate and one week delay period. The second group (using Form II of the MIA) used six texts of health related material consisting of approximately 100 words each, and utilizing the same interval of retention testing. The third group (using Form III of the MIA) used four texts taken from magazine articles, each with approximately 500 words. Retention was tested immediately, after one week and after four weeks. When the text scores were correlated with the MIA, the findings revealed that the links between text recall and metamemory were different for each age group. Additional information on this research is contained in Dixon & Hultsch (1983a, 1983b).

Younger adults scored significantly higher on the Task, Capacity,

and Change dimensions, but there was little difference among all subjects in the Strategy dimension. The same results were found by Bruce et al. (1982) which lends credibility to the MIA. The fact that younger adults outperformed the older group on the Task dimension, reflecting a knowledge of the basic processes of memory, confirmed previous findings that older adults either underestimate the task or overestimate their recall readiness (Lachman et al., 1979; Murphy et al., 1981; Perlmutter, 1978). Scores from the Locus dimension, which had not been predicted, revealed that older adults had less feeling of personal control over their ability to remember than did the younger adults.

For younger adults memory for text was best predicted by the knowledge components of the MIA. The affective dimensions became most salient with the oldest age cohort. Dixon & Hultsch (1983b) suggest that the memory performance of older adults may, therefore, be influenced by non-cognitive factors such as the prevailing notion that memory failure is a certainty. This external locus could be, for some older adults, a self-fulfilling prophecy, and it could be the case that the deficits that have been found in retention were more in the realm of attitude than cognition. Dissemination of research findings using the associative model of learning and remembering may well have left their mark in the mythology of this generation of older adults in terms of their metamemory.

The present study's interest in extending these findings led to the use of an attitude statement which was presented as an additional treatment condition to one of the two strategy groups. It was

hypothesized that a comparison could then be made of the effect of non-cognitive factors on textual retention, independent of the effects that were hypothesized to occur from the adjunct postquestions.

It can be seen that Dixon (1982) was interested in exploring possible age differences in the dimensions of the MIA as they were reflected in the retention of meaningful text. The present study's interest, however, was not to compare data among age cohorts, but to determine whether the results reported by Dixon for his "old" adults would extrapolate to another type of population of the same age. In other words, a part of the present study was an inquiry into whether metamemory, as measured by the MIA, was generally uniform for adults over 60 years of age, or whether other variables interact to influence how this population uses its memory for text.

Schaie (1974) and Wagner & Paris (1981) have argued that more research is needed into how individuals use their metamemory as a guide to the selection of strategies that may be useful in different situations. A better understanding of the relationship between what individuals know about memorizing (knowledge component) may lead to the development of educational strategies designed to insure maximum recall.

Use of Textual Material in Memory Research

Thus far, this paper has examined the overall framework into which its theoretical perspectives on memory fall, and has noted that metamemory is an important part of that framework. For older adults, the kinds of materials used for eliciting performance is equally important because of the conclusions that have been drawn concerning this

group's ability to learn.

Using the information processing approach, researchers in the past two decades have studied adult memory through the use of the retrieval of nonsense syllables, and verbatim or free recall of words. In general, these studies have led to the notion of deficits in ontogenetic memory processes in secondary (long term) memory (Botwinick, 1978; Craik, 1977; Hultsch, 1974, 1975; Kintsch, 1977).

Although this earlier work with simpler materials fell within the multistore memory model, the shift to a more contextual approach has led to studies using the recall of text to determine the locus of the deficits found earlier. The reading of text is an everyday activity in the lives of most adults and is, therefore, thought to be a better measure of memory (Dixon, 1982).

Few studies have been conducted using age related groups and meaningful text, and these have used assorted variables and have shown mixed results. Taub (1976) compared silent reading with reading aloud in young and old adults and found no difference in recall from either method, although younger adults made more concrete responses on multiple choice questions regarding the material. In a later study, Taub (1979) showed that comprehension in terms of a low vocabulary level interacted with a deficit in the acquisition and retrieval components of memory to produce a lower depth of processing and poorer performance in older subjects.

The hierarchical position of the major concepts in a textual passage has been research extensively by Meyer (1977). She reported that when the main ideas of a text were placed high in the content

structure they were recalled more frequently than when the same ideas were placed at a lower level. A study by Meyer & Rice (1981) was conducted to determine whether this "levels effect" (p.254) was age-related. They were interested in determining whether older adults had the ability to profit from a hierarchically organized text when it was provided. Using three age groups of college educated adults, their findings suggested that when ecologically valid materials were used with subjects obtaining high scores on a standardized vocabulary test age-related deficits were not found in the amount of information recalled. Although the younger subjects remembered more of the higher level information and were more sensitive to the hierarchical structure of the material, Meyer & Rice attributed the differences in information remembered to the differences in reading strategies between groups rather than to organizational deficits. They suggest that explicit cues be used, such as signals to focus attention on the hierarchical structure of materials to be remembered.

Another form of representing meaning in text was proposed by Kintsch (1977). This system, using a set of propositions that are hierarchically ordered to form a text base, was used by Dixon et al. (1982) along with input modality (reading or listening), and immediate and delayed gist recall to test retention in adults. Their results did not support those of Meyer & Rice (1981); younger adults remembered the text better than middle-aged and older adults in both recall conditions, and benefited more from reading. A possible lack in older adults' ability to utilize hierarchical organization of the text was thought to be a contributing factor in their poorer performance.

The amount of cognitive capacity, or reserves of energy needed to process complex textual materials is a variable considered to influence retention (Britton, Glynn, Meyer, & Penland, 1982). These researchers found that when the structure of a text was simplified in terms of vocabulary and complexity of sentences, reading time was reduced, retention was improved, and the demands on cognitive capacity, for university undergraduates, were reduced. They also found, as did Brooks et al. (1983) that the insertion of cues or signals alerted learners to the relationships between ideas, thus reducing the amount of cognitive capacity that would have been used if inferences had to be constructed to internalize textual representations. The notion of energy reserves and their effect on text processing seems particularly applicable to older adults, and should be considered when educators are designing learning experiences for this population.

Following an extensive review of age related performance differences in textual recall Hultsch & Dixon (1984) concluded that age differences in text processing are not as widespread as had been found with list materials. However, they suggest that, since multiple contextual factors can interact with age to produce performance differences, more studies are needed utilizing Jenkins (1979) tetrahedral model of memory research. The use of this kind of model is called for by Bovy (1981) who noted that little research has been attempted linking the interaction of instructional design and the distinctive cognitive style of the individual. The present study's use of the MIA to investigate the subjective factors that may affect memory performance, and the Nelson-Denny Reading Test (Nelson & Denny, 1973) as a predictor with

meaningful text is suggested as one means of exploring this interaction.

External Instructional Aids to Textual Recall

There are numerous variables that have been manipulated as external aids to the retention of textual material. For example, Brooks et al. (1983) used embedded headings in a study that investigated how learners might deal with unfamiliar material if relevant schemata were not available; Doctorow, Wittrock, & Marks (1978) used the same learning strategy to produce greater comprehension among sixth graders, while Glynn & DiVesta (1977) studied the use of structural outlines on retention.

As mentioned in Chapter 1, the use of conceptual postquestions inserted between paragraphs of an educational text was chosen as the instructional aid thought to be most beneficial for older adults in the present study. Research in the use of adjunct questions has been concerned with whether they produce more favorable results when they are prequestions inserted before a passage, or postquestions inserted after a passage, and whether they should be factual or conceptual. Retention is generally measured in terms of intentional (based on the adjunct question) or incidental (based on relevant, but non-questioned) learning. Early studies, such as that of Rothkopf & Bisbicos (1967) were based on the associative model of learning which viewed inserted postquestions as stimuli which would reinforce mathemagenic activities when a correct answer was obtained. Conversely, whatever processing activities were used would be extinguished if responses were incorrect. Using this theoretical model as an explanation for the results,

Rothkopf & Bisbicos formulated categories of verbatim questions under a number of conditions. They determined that inserted postquestions had the direct effect of focusing attention on intentional material, and the indirect effect of stimulating incidental recall by alerting learners to the category of question that might be important.

As a general shift from the associative model to a more cognitive orientation became more prevelant, the use of retrieval strategies activated by previously learned information has been studied more intensively. Some of the research in the use of adjunct questions, under this framework has been undertaken by Boker, 1974; Ellis, Konoske, Wulfeck, & Montague, 1982; Rickards, 1976, 1979; and Rothkopf & Billington, 1974. Inherent in these studies is the depth of processing approach (Craik & Lockhart, 1972; Craik & Tulving, 1975) which suggests that the strength of a memory trace is dependent upon the extent to which it received attention, and was fully examined and elaborated upon by associations from previous experiences.

In terms of inserted postquestions, attention has been directed to whether these questions had a backward or forward processing effect. This effect refers to the direction to which the learner's attention is focused after having seen a postquestion. Backward processing has the direct effect of guiding a learner to review the specific content that has been questioned, and the indirect effect of familiarization through a general review of adjacent material. Forward processing is thought to be a general tendency to attend to the type of information that has already been questioned as learners use the postquestions to determine the kind of content on which they should be concentrating. The effects

of forward processing are seen to be stimulatory in nature (Ellis et al., 1982; Rickards, 1979).

Andre (1979) reviewed the literature on adjunct questions and found that regardless of the degree of complexity or position (prior to, inserted, or following text), questions influence the ways in which information is represented in memory. At the time of retrieval, that representation controls the manner in which the stored knowledge will be used. It is with the effects of adjunct conceptual postquestions that the present study is concerned because of an interest in investigating their ability to stimulate mathemagenic activity in older adults. The results from the following studies, using younger adults, suggest that this possibility exists.

Boker (1974) studied the placement of factual adjunct questions and reported the superiority of postquestions over the same type of prequestions in increasing the delayed retention of intentional and incidental learning. Ellis et al. (1982) were concerned with a comparison of postquestions and instructions about what to learn, but if one considers only the results from their control group and their postquestion group, results support those reported by Boker.

When adjunct conceptual prequestions were asked, Rickards (1976) found that they produced superior immediate and delayed recall for factual material, but poorer recall for incidental material. Rickards suggested that these findings were due to the conceptual prequestions acting as an advance organizer for the material to follow. The poorer performance on incidental recall was thought to be due to a focusing effect on information relevant to the questions. However, when

conceptual postquestions were asked, the subjects' retention of incidental material was significantly greater, while retaining an acceptable level of intentional information. When learners use conceptual postquestions to review, it is hypothesized that they also inadvertently attend to material that is related to the specific information they are seeking. It is this hypothesis that the present study was interested in studying, although other instructional aids have produced the same results. For example, Glynn & DiVesta (1976) reported that when an advance structural outline (ASO) was used, more specific facts were produced at recall, and to the extent that this is the goal of the educational experience, the ASO appears to be useful. However, when a retrieval structural outline (RSO) was used, more incidental information was produced in addition to that which was specified as being relevant. These two studies demonstrate the backward processing effect referred to previously. Glynn & DiVesta have noted that what is recalled from text depends on the learner's prior knowledge, and the way in which the organization of this knowledge assists in processing new material. They suggest that performance can be influenced by the way in which instruction controls the direction of these learning processes.

While some researchers prefer pre-instructional processing aids (Glynn & Muth, 1979), the use of such aids appears to be at the expense of incidental learning. Lachman & Lachman (1980) have suggested that for older adults to use their knowledge about the world, a necessary component of memory is that of inference "which involves the ability to construct new information from existing information" (p. 285). Whether

knowledge acquisition takes place inside or outside of the classroom, incidental learning provides a better opportunity to use inference in the constructions of new schemata for processing information.

Summary

Much of the research on the memory of older adults, by cognitive developmental psychologists, has been carried out comparing their performance to that of younger age cohorts. The orienting tasks that have been used have often been meaningless to the subjects, and laboratory rather than naturalistic settings may have been anxiety producing (Botwinick, 1978; Craik, 1977). The results of these studies have, in general, posited the view that there was a decrement in older adults' ability to retain information; the locus and extent of the deficit dependent on the theoretical base of the researcher (Hultsch & Pentz, 1980).

Recent studies, using a contextual approach which takes into consideration schemata for combining new experiences with world knowledge, have revealed the multidimensional nature of memory and have changed the perspectives under which research is being conducted. Designs are currently advocated that simultaneously recognize learners' characteristics, as well as the tasks, strategies and criteria used for judging performance. An additional dimension in the field of comparative ontogenetic approaches is that of individual differences within groups. Wagner & Paris (1981) suggest that these differences be determined before assumptions are made concerning diversity among groups.

Rationale and Hypothesis

The present study was an attempt to combine the preceding empirical findings on text processing and metamemory in a practical application. Within a contextual cognitive framework, a mixed factorial design used university students over 60 years of age as subjects. Meaningful text was selected as the stimulus material because one of the intents of the research was to increase external validity of results.

Before the treatments were administered, all subjects received reading comprehension tests to insure that there were no aptitude by treatment interactions on this variable. Since Dixon & Hultsch (1984, p.13) have suggested that the MIA "remains open and available for further refinement", this instrument was also administered as an opportunity to compare the present study's subjects with another group of the same age on their knowledge about and attitude toward memory.

It was hypothesized that the two strategy groups receiving conceptual adjunct postquestions would demonstrate superior retention of intentional ideas over a delay interval than would the non-strategy group. When text is of an instructional nature, Glynn & Muth (1979) and Meyer & Rice (1981) found that highlighting salient points was an effective way to assist older learners in organizing material more effectively. The recall of incidental content was also expected to be greater for these strategy groups because mathemagenic activities, stimulated by the adjunct questions, are thought to increase absorption of non-questioned ideas (Rothkopf, 1976).

The other level of the dependent variable, the attitude statement presented to one strategy group, was hypothesized to have a

facilitative effect on retention, measured by a greater recall of intentional idea units.

CHAPTER 3

Method

Subjects

The participants were 23 male and 19 female students registered at Concordia University whose minimum age was 60.

Table 1

Scores from the Nelson-Denny Reading Comprehension Test, Form C (NDRCT) and demographic characteristics reported by the subjects are shown in Table 1.

Descriptive Characteristics of Subjects

Demographics	M	SD	Range
Age	64.9	4.13	60-79
Years of Schooling	14.8	2.82	8-20
N-D comprehension	16.5	6.86	3-30*
N-D reading rate	255.0	86.50	143-561**

* maximum possible score 36

** maximum possible score 636

Additional demographic information revealed that 7 subjects (17%) were graduates, 26 (63%) were undergraduates, and 8 (20%) were independents. In terms of academic background, 26 subjects (63%) had an arts background, 5 (12%) had a science background, and 10 (24%) had both arts and science in their background. The subjects were also asked for a subjective assessment of their health relative to acquaintances

of the same age. General health was reported as very good by 24 (59%), good by 10 (24%), and moderately good by 17 (17%). Eyesight was reported as very good by 12 (29%), good by 21 (51%) and moderately good by 8 (20%). Hearing was reported as very good by 20 (49%), good by 11 (27%), and moderately good by 10 (24%).

After the groups had been formed, one subject in the questions only treatment group chose not to participate, leaving 41 subjects. In addition, one subject in each of the two strategy groups was unable to return for the delayed post test. This left a total sample of 41 subjects in the immediate condition and 39 subjects in the delayed condition.

Design

The design was a three treatment (questions plus attitude statement, questions alone, read only control) by two time (immediate, delayed) mixed factorial. Treatment conditions were between subjects, and levels of time were treated as repeated measures.

Instrumentation

Metamemory in Adulthood (Dixon & Hultsch, 1984). This instrument was administered to determine whether the findings of Dixon & Hultsch, relative to older adults' metamemory and memory for text, would extrapolate to a different type of text and different older adult population.

Nelson-Denny Reading Comprehension Test, Form C (Nelson & Denny, 1973. Due to the length of the experiment, only the Reading Rate (1 minute) and Comprehension Section (19 minutes) were administered. The NDRCT was used as a covariate because its test items were constructed

to assess a subject's ability to understand specific facts, to identify associations, and to abstract ideas from text. These are the abilities needed to perform the task designated for the present study, and are believed to covary with the dependent measures. Before this analytical approach was used homogeneity of regression, an assumption of covariance analysis, was tested.

Adjunct questions. Four English teachers independently identified the topic sentences within each paragraph of the instructional material, defined as the sentence that most accurately conveyed the main idea of the paragraph. A consensus of three judges determined the idea units upon which the adjunct conceptual questions were then developed. For the purposes of this study, idea units were operationally defined as complete sentences, clauses or phrases carrying a complete idea. Conceptual questions were those having no word overlap from the text to its referent, thereby requiring the reader to abstract idea units from the text, as directed by the questions (Andre, 1979). For each two consecutive paragraphs two questions, based on the previously identified idea units, were inserted following the passage, providing a total of 18 questions.

Intentional and incidental concepts. The dependent measures were calculated by totaling the number of intentional and incidental concepts recalled by the subjects at each of the time intervals. The four raters who were to score the protocols were given instructions concerning the division of the text into complete idea units, (See Appendix A). Again, consensus of three raters determined the units which were then separated into intentional and incidental categories.

An intentional unit was operationally defined as an idea that could be recalled from the conceptual questions inserted into the text after each two successive paragraphs; an incidental unit was a non-questioned idea included in the text. The 42 intentional idea units, and the 87 incidental idea units are listed in Appendix A.

Materials

Instructional text. A 1552 word passage on weather forecasting was presented as the stimulus material. Pica type was used, double spaced, on seven pages of 8-1/2 x 11 inch white paper for the text without questions, and eight pages for the text with inserted questions. The text was entitled "Forecasting: How Exact Is It?", by Shannon Brownlee, published in Discover Magazine, April, 1985. Permission for its use was obtained from the publisher, Time, Inc. The article dealt with the need for accurate forecasts, the origin of weather patterns and the factors contributing to imprecise predictions, and the uses of advanced computer technology in providing present day forecasts. In addition, the text presented a number of experimental designs, under consideration at the present time, intended to increase forecasting accuracy in the next decade.

This article was chosen because, (a) it was similar to an instructional text, (b) it was thought to be a subject in which there would be general interest, (c) it appeared to be of sufficient difficulty to provide a test of the instructional aid under consideration, and (d) since no courses in meteorology are offered at Concordia, no potential subjects would have to be excluded from the available pool due to familiarity with the content. The text actually proved to have

been a valid choice in these respects because none of the subjects had read the article, and only one individual professed more than a vague knowledge of weather systems.

The article contained 30 paragraphs, 18 of which formed the experimental text. These paragraphs were extracted in the same order as that in which they originally occurred. The material selected for use was of a factual nature; material eliminated from the original text was in reference to the pictures contained therein, and the examples used by the author to clarify the concepts being discussed. There was a dual purpose in reducing the length of the article, (a) providing a reasonable memory task for the subjects, (b) eliminating the examples reduced the possibility that they might confound the effects hypothesized to occur from the use of adjunct postquestions as an instructional aid.

An additional modification of the text was made by the researcher, as shown in the sample paragraphs in Figure 1. The words underlined (in the sample, but not in the experimental material) were added to explain the somewhat technical terms micro, meso and synoptic. (See Appendix B for the entire experimental text with adjunct conceptual postqueations.)

The scale of a forecast depends on the size of the atmospheric events it encompasses. Small micro scale and medium (meso) scale forecasts cover areas up to 30 miles in diameter, and take in single clouds, squall lines, tornadoes, and tropical storms. These forecasts, largely a matter of extrapolating from satellite pictures and local observations, are the trickiest of all, because weather patterns on such a small scale can appear without warning.

The next larger scale (synoptic) comprises weather patterns hundreds of miles across. The synoptic scale takes in vast migratory storms, like hurricanes, which are tracked by means of observations made simultaneously over hundreds of square miles. Although they can be just as dangerous as storms of the mesoscale, synoptic patterns generally build up over longer periods of time.

What factors limit local weather predictions?

How do weather samples using greater distances differ from the regional variety?

Figure 1. Sample paragraphs of experimental text with adjunct conceptual postquestions.

The text with inserted questions was then pilot tested by eight adults of varying backgrounds who, at their own pace, completed the reading and then tested their recall on an immediate posttest. The testers were provided with a booklet of blank pages and the following instructions: "Please write, in your own words, everything that you can recall from the text you have just read. Please do not refer back to the text". These recall conditions were the same as those that were planned for the actual experiment. Seven of the eight respondents reported that the questions assisted them in organizing the material, and they thought that this organization probably increased the amount of material they were able to recall.

Attitude statement. The attitude statement shown in Appendix B and seen in Figure 2, was designed to alert subjects to the source of the mythology concerning memory failure. It was based on studies by Davies (1980), Dixon & Hultsch (1983b) and Wagner & Paris (1981) who have suggested that the executive control of memory, of which meta-memory is a component, can be affected by one's attitude toward the ability to remember.

Interpolated task. When each subject had completed studying the text a demographic questionnaire was administered, as an interpolated task, before beginning the posttest free recall. The questions were typed on one 8-1/2 x 11 inch sheet of white paper, and were intended to insure that recall was not simply a function of short term memory. (See Appendix B.)

The results of recent research from educators and psychologists interested in adult development throughout the life-span have shown that older adults are capable of remembering almost as well as their younger counterparts.

The myth that memory failure increases dramatically with age stems from the psychological literature, and is based upon word-list studies, speed of recall and nonsense syllables. In recent years psychologists have begun to question whether the results of these studies are valid. Recent studies have indicated that perceived memory loss in older adults is more a function of attitude than physiological factors.

As a matter of fact, some scientists now think that many older adults can perform better, on some tasks, than those who are younger. It appears to depend on the development of a positive attitude toward the ability to remember, so that all of an adult's past experience and knowledge can be integrated with the new material being learned.

Figure 2. Attitude Statement on the source of the myth concerning memory failure in older adults.

Experimental package. For the experiment each subject was given a precoded folder with all materials facing downward. All subjects received: (a) the MIA, (b) the NDRCT, Form C, (c) Interpolated Task, (d) lined booklets which contained instructions to subjects to write, in their own words, everything that could be recalled from the text, (e) a 2 inch x 2-1/2 inch card containing the subject's coded indentification plus the date, time and place of the second session. In addition, depending on the treatment condition, the following items were added:

Group One .....Attitude Statement, Instructions (A) and Instructional Text with Adjunct Conceptual Postquestions

Group Two .....Instructions (A) and Instructional Text with Adjunct Conceptual Postquestions

Group Three .....Instructions (B) with Instructional Text

Procedure

Initial contact. Letters from Professor F.D. Hamblin, Director of Institutional Research, were sent to a randomly generated computer listing of 175 Concordia students (minimum age, 60) explaining the purpose of the study, and inviting them to participate. Provision was made for the respondent to designate on which campus and at what day and time s/he would prefer to be tested. (See Appendix A.)

Assignment to treatment conditions. The design of the study included three treatment conditions: (1) text with adjunct questions and attitude statement; (2) text with adjunct questions only; (3) read only control. While the subjects in each condition had instructions and

materials specific to their treatment (See Appendix B), a major focus of this study was the arrangement of the testing situation in such a way that its environment would be as naturalistic and relaxed as possible. Criticism of this area of methodology in research carried out with older adults has been addressed by Craik (1977), Perlmutter (1978) and Wass & Olejnik (1983). To this end, the participants were urged to ask questions whenever necessary if they were unsure of some point in the procedure. It was, therefore, not possible randomly to assign subjects within a group to one of the three treatment conditions. It was foreseen, for example, that a subject who was in the control condition would have been aware of a difference in treatments if a subject from either of the two other conditions were inquiring about an inserted question; in the same manner, subjects reading and commenting about the attitude statement would have puzzled those in the two other treatment conditions.

The need for separate testing led to a problem in the random assignment of subjects to treatment groups, therefore, the following procedure was used. When a group of four to six subjects chose a particular time, day and campus, they were given a randomly selected treatment condition (one of three color coded cards was drawn from an envelope). Assignment without replacement then followed for the next group, With the third group being given the remaining condition. Since this grouping (four to six subjects) occurred in only three time periods, the remaining subjects were tested singly or in pairs, with the same method of assignment without replacement being used to ensure groups of equal size.

Although this was not the preferred method of random assignment, it appeared to be the most feasible compromise considering that the subjects were volunteers and were being asked to attend two testing sessions, as well as to perform a lengthy task. When all of the testing had been completed it was observed that the three treatment groups were fairly evenly divided (eight males, six females; six males, seven females; eight males, six females), as well as the days, times and locations of testing. The researcher was not aware of which subjects had been the first to reply to the letter inviting them to participate in the research, so there was no knowledge of which subjects were more interested than others. The possible testing times covered a period of four hours, from 0900 - 1300 hours, making it less likely that the time of day being chosen would influence a subject. It is thought that the deviation from the standard practice of random assignment did not produce a systematic influence in the groups' composition, and was outweighed by the positive atmosphere of the testing situation.

Individual testing would have been the preferred method, but it was not possible in the time frame available for the study. Practical considerations dictated that the subjects should not be contacted until their spring exams were finished, but that testing must be completed before vacation plans interfered. In addition, the researcher preferred to conduct all of the testing to ensure, as much as possible, that the conditions were similar for all subjects.

Testing procedure. Classrooms on each campus were reserved for testing purposes, and at the beginning of each session subjects had an initial period to become relaxed and familiar with the test

surroundings. It was explained that the purpose of the study was to aid instructional technologists through a better understanding of the ways in which older adults learn, and that each group would be learning in a different way. Subjects were told that all of the results would be coded and confidential, and that it was hoped that they would have an enjoyable learning experience. When the subjects were ready to proceed, each individual was given a folder relevant to the treatment condition, with all of the material pre-coded with the subject's identification number. They were asked not to look at the contents until instructed to do so.

Subjects were then directed to remove the MIA and to complete it, taking as much time as necessary. When this task had been completed they were told to remove the NDRCT. This timed test was administered according to the directions contained in the examiner's manual. It was explained that the results from these two tests would be made available to subjects through the use of the assigned codes.

The treatment group using the attitude statement was then told to study the statement as long as was necessary, and then to proceed to the text, following the instructions that accompanied it. The two other groups proceeded directly to the instructions for studying the text relevant to their treatment condition. Throughout the testing period all subjects were encouraged to ask questions if the directions were not clear. All subjects proceeded at their own pace. When each subject indicated to the researcher that the reading task had been completed s/he was quietly instructed to complete the interpolated task, and then to follow the directions in the free recall booklet. When the posttest

began, referral to the text was not allowed. Subjects were free to leave when they had written as much as they could remember, asked to return to the same place in one week, and reminded to retain their coded card.

The following week each subject was given another booklet, with their code number on it. They were then instructed to recall as much of the text as they could remember, in their own words, taking as much time as was needed.

When each subject had finished they were thanked for their participation and told that their individually coded scores on the MIA and NDRCT would be available at the Centre for Mature Students on each campus, along with the study's results, after an analysis had been completed.

Scoring

Protocols from nine subjects, (three from each treatment group) at each of the time intervals, were randomly selected and given to four raters who were blind to the treatment conditions. Instructions for scoring can be seen in Appendix C. Each rater was also given a list of the previously identified intentional and incidental idea units. When each of the raters had completed scoring the nine sets of protocols, interrater reliability coefficients were calculated according to Winer (1972, p.289). The coefficients of raters for intentional idea units in the immediate and delayed recall measure were .98 and .90 respectively; for incidental idea units the coefficients were .95 and .87 respectively. Since the raters were in agreement the remainder of the protocols were divided among them and the scores from the nine already

completed were averaged to produce a raw score for those subjects. Appendix C contains the raw scores for all subjects.

CHAPTER 4

Results

The purpose of this study was to determine the effects of conceptual adjunct postquestions and attitude toward memory on older adults' retention of a meaningful instructional text. The dependent measure was examined over an immediate and delayed interval.

Homogeneity of Regression

Tests for homogeneity of regression of the NDRCT on the dependent measures were conducted at each level of time. Since analysis of covariance assumes that a single within-cells regression coefficient can be used to adjust the sum of squares, this test is necessary to demonstrate that no treatment by covariate interactions exist. Table 2 shows the means and standard deviations for the reading measures across the levels of the design.

Standard multiple regression with dummy coding was used to test the assumption of parallel regression lines (See Tables 3 and 4). F ratios for interactions between treatments and the NDRCT were not significant, $p > .05$ indicating that homogeneity of regression was not violated. Recall at the immediate intentional level was $F(2,35) = .31$, at delayed intentional, $F(2,33) = 1.9$, at immediate incidental, $F(2,35) = .69$, and at delayed intentional, $F(2,33) = .02$.

Table 2

Means and Standard Deviations for Reading Comprehension Measure Between Treatment Groups

Group	n	M	SD
Strategy/Attitude	14	15.77	7.07
Strategy	13	18.08	6.20
Control	14	16.14	7.88

A significant correlation was found at each level of time for the reading measure and intentional recall, $\gamma = .39$, $p < .01$ in the immediate condition, and $\gamma = .59$, $p < .01$ in the delayed condition. No significant correlation was found for incidental responses at either level of time. Due to the nature of incidental recall it was not surprising to find that the NDRCT had no effect on this response measure.

Analysis of Covariance

A 3 x 2 analysis of covariance (treatment by level of time) was performed on the scores derived from all subjects' free recall of intentional and incidental idea units on the immediate and delayed posttests. This procedure was conducted to test the experimental design for the main effects of the instructional strategy and its interaction with the time intervals. The unadjusted means, standard deviations and adjusted means are depicted in Table 5. A significant main effect was found for the factor, strategy, on the intentional idea units recalled, $F(2,35) = 5.81$, $p < .007$. No significant main effects were found for

Table 3

Regression of Intentional Recall and Reading Comprehension Over Time Intervals

Source	df	MS	F	p	γ^2
		Immediate Measure			
Reading (R)	1	.18	9.14	.01	.18
Strategy (S)	2	.08	4.07	.05	.16
R x S	2	.01	.311	>.05	.01
Error	35	.02			
		Delayed Measure			
Reading (R)	1	.14	8.14	.01	.14
Strategy (S)	2	.10	5.82	.01	.20
R x S	2	.03	1.91	>.05	.07
Error	33	.02			

Note. γ^2 refers to the square of the multiple correlation for each component in the model.

Table 4

Regression of Incidental Recall and Reading Comprehension Over Time Intervals

Source	df	MS	F	p	γ^2
		Immediate Measure			
Reading (R)	1	.03	1.05	>.05	.03
Strategy (S)	2	.02	.62	>.05	.03
R x S	2	.02	.69	>.05	.04
Error	35	.03			
		Delayed Measure			
Reading (R)	1	.02	.80	>.05	.02
Strategy (S)	2	.00	.12	>.05	.00
R x S	2	.00	.02	>.05	.00
Error	33	.03			

Note. γ^2 refers to the square of the multiple correlation for each component in the model.

Table 5

Unadjusted Means, Standard Deviations and Adjusted Means of Intentional and Incidental Recall as a Function of Textual Presentation

Group	Immediate n	M	SD	M^{1}_{adj}	Delayed n	M	SD	M_{adj}
				Intentional Recall				
Strategy/ Attitude	14	8.62	2.96	8.80	13	6.70	3.45	6.87
Strategy	13	6.08	3.85	5.77	12	5.92	4.06	5.60
Control	14	4.71	3.83	4.82	14	2.93	2.46	3.03
				Incidental Recall				
Strategy/ Attitude	14	10.38	5.90	10.50	13	9.54	5.46	9.65
Strategy	13	8.67	5.73	8.47	12	9.00	5.94	8.80
Control	14	10.71	7.52	10.78	14	8.50	6.26	8.56

Note. Maximum intentional = 42

Maximum incidental = 87

1 Regression coefficients (within cells): Intentional = .21

Incidental = .13

the recall of incidental material; no significant interactions were found between treatment strategies and delay intervals. The absence of interactions between test times indicated that the same trends were found for the two time intervals. (See Table 6.)

Post hoc Analysis

In order to determine the locus of the significant main effect of the strategy factor, a post hoc analysis was conducted. After unweighted means were used to adjust the treatment groups, Tukey post hoc comparions were computed between the posttest means of all possible pairs of intentional idea units recalled in the three treatment conditions. The combination of inserted questions and attitude statement was significant at the $p < .01$ level when compared to the read only control group. No other combination of means reached significance.

Study Time

Although not included in the original design, the amount of time which subjects spent studying the text (before indicating that they were certain they were familiar with it) varied between the strategy and control groups. For subjects in the two groups using adjunct questions, study times ranged from 20 minutes to one hour (M = 32.2 min.); for the read only control group, study times ranged from 15 min. to 35 min. (M = 20.7 min.).

Table 6

Ancova Summary of Intentional and Incidental Recall

Source	SS	df	MS	F	p
		Intentional Recall			
Strategy	206.44	2	103.22	5.81	.007
Regression	167.70	1	167.70	9.45	.004
Error	621.29	35	17.75		
Time	32.41	1	32.41	16.10	.001
S x T	11.86	2	5.93	2.95	.07
Error	72.47	36	2.01		
		Incidental Recall			
Strategy	26.01	2	13.40	.19	.83
Regression	66.55	1	66.55	.93	.34
Error	2504.42	35	71.55		
Time	16.05	1	16.05	2.94	.09
S x T	21.13	2	10.56	1.94	.16
Error	196.36	36	5.45		

MIA

The final version of the MIA, (Dixon & Hultsch, 1984) as described in Chapter 2, was used to ascertain whether the relationship between metamemory and memory for text in the present study would be similar to that found in the old adults from Dixon's (1982) sample. The MIA contained 120 items relating to its eight subscales, (Strategy, 18 items; Task, 16 items; Capacity, 17 items; Change, 18 items; Activity, 12 items; Anxiety, 14 items; Achievement, 16 items; Locus, 9 items) randomly distributed throughout the instrument. Each item had a scoring range between one and five, with five being the preferred response in all cases. For the purpose of analysis it was necessary to re-assemble the items, placing each response into its assigned subscale. The responses were then scored; each subject received a score for each of the 120 items, according to the answer key provided by Dixon & Hultsch (1984).

Due to the number of subjects relative to the number of items in the MIA, a factor analysis of the data was not possible. The use of the MIA in the present study, however, was one of comparing two populations of the same age, who varied with respect to type of task and educational status. Since, as previously mentioned, the MIA is open for further investigation (Dixon & Hultsch, 1984), his assertion that the instrument had psychometric validity was accepted for the purpose of this study.

An item to total correlation, using coefficient α was calculated for each subscale to determine the reliability of subjects' responses within each of the metamemory factors. Table 7 shows the comparison of

Table 7

Comparison of Reliability Coefficients of the MIA Subscales Between Dixon's Old Adults and the Present Study

Subscale	Dixon (n = 50)	Present Study (n = 41)
Strategy	.87	.85
Task	.78	.72
Capacity	.86	.79
Change	.90	.90
Activity	.46	.54
Anxiety	.82	.83
Achievement	.61	.82
Locus	.71	.79

α values found in the present study with the sample of Dixon's (1982) old adults. It can be seen that the fifth factor, Activity, did not show a high level of internal consistency in either sample. This result (i.e., a range of .45 - .66) was found in all of the samples which Dixon used in constructing the instrument. According to Dixon, however, Activity was retained as a separate subscale because in his factor analysis none of the other scales contained any items which belonged, by definition, to that subscale.

Pearson product-moment coefficients were calculated between the items of the MIA subscales, and the correlation of intentional and incidental idea units with the same subscales across each level of time. (See Tables 8 and 9.) Inspection of all variables indicated a generally low correlation among both the subscales of the MIA, and the same subscales with the dependent measures. Because of this a complete regression analysis was not deemed necessary.

Due to the fact that the population means and standard deviations from Dixon's (1982) sample were known, Z scores from that sample and the present study were computed to determine whether the two groups represented a similar population. Table 10 reveals that the present study's subjects differed significantly on two of the subscales, Change and Anxiety.

Table 8

Intercorrelation of MIA Subscales

Subscale	Strategy	Task	Capacity	Change	Activity	Anxiety	Achievement	Locus
Strategy	1.0							
Task	.36*	1.0						
Capacity	-.01	.06	1.0					
Change	-.25	.07	.57*	1.0				
Activity	.10	-1.3	.04	.09	1.0			
Anxiety	.29**	.06	-.56*	-.54*	-.22	1.0		
Achievement	.44*	.25	.37*	.06	.01	-.06	1.0	
Locus	.18	.26**	.52*	.46*	-.30**	-.23	.53*	1.0

* $p < .01$

** $p < .05$

Table 9

Correlation of Intentional and Incidental Idea Units with MIA Subscale at Each Level of Time

	Immediate		Delayed	
Subscale	Intentional	Incidental	Intentional	Incidental
Strategy	.03	.06	-.07	-.12
Task	-.02	-.01	-.08	.04
Capacity	.10	.12	.12	.15
Change	-.18	-.00	-.16	.05
Activity	-.10	-.04	-.08	-.21
Anxiety	-.13	-.30*	-.16	-.32*
Achievement	-.00	.03	-.05	.01
Locus	.06	.14	.09	.29*

*. $p < .05$

Table 10

Means, Standard Deviations and Z Scores of MIA Subscales for Dixon's Old Adults and Present Study

Subscales	Dixon* M	Present Study** M	Dixon SD	Present Study SD	Z'	Scoring Range
Strategy	64.9	63.6	11.5	9.9	.82	18-90
Task	61.5	62.2	6.6	6.5	-.35	16-80
Capacity	53.6	56.8	10.3	7.8	-1.85	17-85
Change	46.3	56.8	11.5	11.0	-6.77	18-90
Activity	23.6	25.9	3.9	4.0	-.88	12-60
Anxiety	46.5	38.4	8.4	7.5	4.40	14-70
Achievement	62.5	59.4	5.5	10.3	1.59	16-80
Locus	30.9	33.2	4.8	5.4	-1.00	9-45

* $n = 50$

** $n = 41$

Note. Z' refers to the difference between Z scores in the two samples.

CHAPTER 5

Discussion

The present study was based on the notion that the context of a learning experience, stressing the interrelationship between learner characteristics and the educational task, might suggest the instructional aid which would produce the greatest text retention. Therefore, this experiment reflects multiple objectives: to study whether for older adults, the use of an instructional strategy would improve retention of both intentional and incidental facts from a technical text; to test whether providing subjects with a positive statement about memory as an enduring ability might affect their performance; to investigate the predictive ability of an instrument psychometrically designed to correlate an individual's knowledge and attitude toward memory with the retention of text.

The last objective was connected to the issue of metamemory in terms of whether what one knows and thinks about one's memory will determine the strategies used in demonstrating recall. If, as has been suggested in research literature (Brown, 1978; Bruce et al., 1982; Dixon & Hultsch, 1983b; Murphy et al., 1981) there are age and developmental differences in this aspect of memory, instructional designers may be more effective if these variables could be identified. Abilities that exist within individuals of the same age cohort in relation to their metamemorial awareness may also fall on a continuum, and instructional aids might profitably be developed to address these within-group differences.

It is acknowledged that the results from this study may have limited generalization. The population of older adults (i.e., students over 60 who are studying in an educational environment) is not large, and even the present subjects may not be representative of students this age. The subjects had volunteered for the study and it may have been that they were more curious, self-confident, and interested in the topic of memory than were their peers. In addition, the number of volunteers was a disappointment; the statistical results lack the power that would have been available had the treatment groups been larger.

Instructional Strategy

The hypothesis that adjunct conceptual postquestions have the effect of assisting older learners to process text to a greater depth, thereby producing superior retention of factual information over a time interval, appears to be justified in the present study. These results were found after the three groups were equated for their ability on reading comprehension.

Intentional learning. The text was chosen to test retention under the most stringent conditions (i.e., where relevant schemata for organizing material were probably absent). The embedded questions served the purpose of inducing mathemagenic behaviors by simulating test-like events as has been discussed at length by Rothkopf (1965, 1976). In addition, Craik and Tulving (1975) have stressed the saliency of what a learner actually does in terms of analyzing content while attending to a learning task.

The results from embedded questions, designed to stimulate the

abstraction of relationships between ideas in the text, supports Rothkopf's (1976) theory that more mathemagenic activity is necessary when schemata are not present to make inferences from a difficult text. One of these activities, as suggested by Bovy (1982) is the use of supplanting techniques to enhance performance.

In terms of the attitude statement, which was the only aspect differentiating the two strategy groups, it would appear that little reinforcement is needed to motivate older learners to initiate mathemagenic activities in processing text to a greater depth. The original intent of the present study was to have been a fully crossed design, with the additional experimental group being composed of text without questions plus the attitude statement. The lack of volunteers precluded this design, but if the experiment were to be replicated with a larger pool of subjects, results might clarify the performance attributed to a positive attitude on the ability to maintain memory throughout the lifespan. The attitude factor is one of a learner's characteristics which should be considered if replication of these results were to be attempted. The effects found may have occurred because the investigator was "preaching to the converted" in this study. These subjects probably had some degree of confidence in their ability to process text, otherwise they might not have attempted university level courses. To persuade older adults, not in school, that they have the capacity to succeed would undoubtedly require a greater effort in terms of counseling or orientation programs.

The concept of the cognitive effort spent in processing text has

received little attention in research with older adults, and may have been an additional factor contributing to the difference in scores between treatment groups. Since Britton et al. (1982) found cueing devices to be effective in reducing cognitive effort for young adults when text was difficult to comprehend, it may have been that older adults, presumably having lower energy levels, would be affected to a greater degree. In this regard, the use of adjunct questions to signal the interrelationship of ideas may have assisted the two strategy groups and reduced the effort spent on the actual assimilation of the textual materials. The control group may have grown tired of attempting to find a framework for all of the ideas in the text, and dispersed their energy ineffectively, resulting in little retention of the important content. This possibility parallels the findings of Meyer and Rice (1981) that older subjects were less able to distinguish irrelevant from important information, and that explicit cues were needed to signal the type of information that was relevant.

There was little difference in the delayed recall scores between the two strategy groups, therefore, it appears that the attitude statement had its greatest impact on the immediate condition. Whether this occurred because the group receiving the statement exerted more effort in initially studying the text is not known, but its effect did not last over the time interval.

Time on task. Relative to the variation in time spent studying, the poorer recall scores of the control group supports the findings of Murphy et al.(1981) that older adults may fail to monitor their

readiness to recall, characterized by not knowing how long to study. Rothkopf (1976) supported the view that the conditions that keep a learner working on a task for a longer period (in this case the inserted questions) may facilitate retention from written materials. He noted that manipulation of the environment was an effective method of utilizing stimuli to enhance learning.

It is possible that several factors may have combined to act disadvantageously for the control group in extracting intentional information from the text. They may have overestimated their ability to judge what and how much they could remember because they did not have tasks to perform which would act as cues and increase mathemagenic activity. While they may have been certain they understood and were familiar with the text, they had actually failed to discover its objectives. If there were an absence of schemata affecting recall in the immediate time interval, an additional week could only exacerbate retention difficulties. The amount of intentional content demonstrated by this group, at both time intervals, reinforces the findings of Dixon et al. (1982), Glynn & Muth (1979) and Hultsch (1974) that older adults either lack or fail to use organizational strategies when presented with a learning task. Since results of this type have been known for some time, the contention of Wass & Olejnik (1983) that research findings have not been translated into effective educational programs would appear to be valid.

While inserted conceptual postquestions worked well as an instructional aid, other types of strategies (i.e., advance organizers,

headings or note taking) might be worth investigating for comparative purposes. An awareness that context will not be the same for each individual suggests the use of a broad spectrum of research designs tested under naturalistic conditions as a way of assessing the learning aids best suited to the older learner.

Incidental learning. Much of the research on processing activities previously mentioned has been based on the premise that mathemagenic behavior is being exhibited, and that being the case, instruction can be designed to take advantage of the phenomenon. Rothkopf (1976) has shown that the recall of incidental content which had not been questioned is evidence that these activities were actually taking place when postquestions were embedded within intervals of a text.

Although the recall of incidental content between treatment groups in the present study was not found to be significant, the patterns were similar to those found in studies with young adults. First, Boker (1974) found that retention of intentional content did not act as a deterrent to the recall of incidental ideas. In addition, Boker's subjects had not been permitted to review the material that had been presented to them, and in his suggestions for future research, he questioned whether incidental learning from an instructional text would have been depressed if subjects had been given this option. The present study, which allowed unlimited time for review suggests that for the two strategy groups the retention of incidental content was not negatively affected by the amount of time spent in intentional learning. Secondly, the importance of learning information other than that

covered by questions was an important part of the educational process stressed by Ellis et al., (1982). They considered incidental learning to be a positive indirect effect of adjunct postquestions. Finally, Rickards (1976) found that immediate retention of incidental material was greater than delayed retention.

The use of instructional aids to indirectly promote incidental learning may be more important for the older age group because it is thought that their larger data base from past experience may assist in making inferences from new to old information, thereby compensating to some extent for the loss of organizational ability (Perlmutter, 1980).

Metamemory and the MIA

In the lives of older adults the acquisition of content from instructional media can have many purposes. For knowledge to be translated into effective usage, Lachman & Lachman (1980) have found metamemory to be implicated because it serves the function of helping the individual to continue searching for potentially recoverable information. "Metamemorial control processes are posited as the hypothetical mechanisms that direct efforts to retrieve and draw inferences" (p.285). As previously mentioned, most laboratory task results were analyzed on performances derived from experimentally acquired material, and it was these results upon which assumptions of memory deficits were made about older populations. Ecologically valid tasks in a naturalistic setting, however, are looking for knowledge acquisition based on the ability to use the life-span development of permanent memory in the process of retrieval and inference.

Within a contextual perspective, metamemory is a subjective construct comprising a number of capacities which are thought to control performance on memory tasks. Dixon's (1982) attempt at identifying and measuring these capacities resulted in the MIA. As an instrument to study knowledge and attitude about memory, this instrument has been shown to have value but the use of its subscales as a predictor of the ability to retain instructional text was not shown to be reliable for the population represented by this study.

It is not often that raw data from other research is available from which to calculate differences in Z scores, and thereby to compare two populations, and the possibility afforded a possible explanation of the differing results from the two studies. It was noted in Chapter 4 that comparing scores on each of the subscales revealed statistically significant differences on two of the dimensions of metamemory. First, scores from subjects in the present study on the subscale Change indicated a stronger perception that their memory would either remain stable or improve over time. These results may be explained by the fact that these subjects, having elected to place themselves in a dynamic learning environment, did so because of unidentified factors which had previously convinced them that memory loss was not inevitable. Their score on the Change dimension actually compared favorably with that of Dixon's middle-aged (age 39-58) subjects.

Secondly, their lower score on the Anxiety dimension appeared to show less awareness of the effects that anxiety might have on cognitive performance. However, an analysis of Dixon's (1982) explanation of the

scoring interpretation of this subscale differs from that noted in Dixon & Hultsch's (1984) MIA, which used the same items. For the purpose of scoring Anxiety, Dixon (1982) stated that "a high score indicates a high level of anxiety associated with cognitive tasks" (p.57), whereas in the MIA as presented in the present study, it was stated that "a high score indicates a high level of knowledge regarding the reciprocal influence of anxiety and cognitive performance" (p.5). The items classified under Anxiety asked for a subjective assessment of the way respondents felt in a variety of situations. The scoring system, however, was designed to reflect that what subjects knew about the effects of anxiety on performance and how they reacted, personally, were the same. It would appear, therefore, that the items, as stated in the MIA, did not reflect the scoring interpretation, and no comparisons can be drawn between differences in the two populations.

Differences in Z scores on the other dimensions of metamemory revealed that both populations had a similar knowledge and awareness of memory processes. It might therefore be expected that there would have been similar correlations between text retention scores and those of the MIA. Since this instrument has been shown to have factor validity, it is suggested that the dimensions of the MIA did not tap the metamemorial processes used for the type of task designated in the present study. Dixon's (1982) subjects read four short (500 word) passages taken from magazine articles, whereas the educational task designed for this investigation was lengthy and difficult as determined by self-reports from most of the participants. However, it was decided

that to properly test the instructional strategy, the task had to be of that quality. Dixon & Hultsch (1984) have stated that the MIA is in its developmental stages, and it is suggested that, while this instrument can tap metamemory and its relationship to an everyday reading task, future research might profitably investigate the possibility of higher order metamemorial knowledge and attitudes to discern whether more abstract and demanding tasks utilize more multidimensional aspects of the construct.

The lack of correlation between the MIA subscales and text retentions in the present study lends credence to Jenkins' (1979) concept of models used in memory research. Future investigations whose interest is on methods to increase retention and retrieval of textual content in older adults might be designed on a continuum reflecting the multidimensional nature of metacognition and metamemory (with particular attention to the Change dimension). Bovy (1982) has suggested elements of this design in her model of matching cognitive skills and instructional strategies with the instruction or training that is offered.

Educational Implications

The purpose of an educational experience is thought to be a fairly permanent retention of the learned material. Older adults have been shown to have deficient acquisition strategies, therefore, the use of supplanting materials, as shown in the present study, can prove to be an effective method of assisting this population in the organization of the to-be-learned material. Knowing more about what the older adult is actually doing while encoding, and how instructional aids affect

mathemagenic behavior can help to determine the aids that are most appropriate for different types of learners and different media. When new concepts are introduced and where relevent schemata are not available, older adults probably need additional assistance in focusing on the instructional objectives as a means of reducing cognitive effort.

Educational technologists should be aware of the learning characteristics of this group when they are designing instructional materials. As an example, the expected outcome of a learning experience might determine whether intentional, incidental or both types of learning could best achieve the intended goal. Stressing acquired knowledge rather than basic memory processes will favor the older learner. The types of instructional aids that can best facilitate deeper prdcessing and assist these adults in the development of schemata through the integration of new information with the world knowledge they already possess has been shown to be effective (Perlmutter, 1980). However more research is needed concerning the ways within-group members of this population think about their memory, and how their knowledge and attitude in turn influence the idiosyncratic mnemonic skills they bring to an educational setting. Hurst (1980) used elementary school teachers as subjects to investigate the relationship between cognitive skills and attitude, and found that they were hierarchically related. She suggested that groups of learners could be identified by their similar cognitive affective capabilities. This notion appears to be even more appealing for use in studies with an

older population. Research designs could concentrate on the interaction of person-task-strategy variables and on how different learning plans are acquired and used. Additionally, it will be important to find out how to assist the older population in adapting to a task and demonstrating knowledge, because as Jenkins (1979) has noted, the context in which people function may be the greatest change accompanying aging.

The increasing demand by older adults for access to educational experiences suggests that more must be done to design instructional materials best suited to their needs. A team approach representing such disciplines as educational technology, instructional design, gerontology and educational psychology could combine with content experts to design programs appropriate for this population. For classroom situations, supplemental instructional aids could be presented along with textbooks already in use. This combination could assist older learners in organizing and retaining the to-be-learned material, and incorporating life-span experiences into building new schemata.

Finally, but not least importantly, the use of formative evaluation in the ongoing assessment of the worth of projects under development would yield much needed information about within-group differences before funds were spent on materials that were either unworkable or unwanted by their recipients. Romiszowski (1984, p.236) has noted that "learners themselves may be interested in participating in the evaluation of the teaching/learning process, in order to be able to voice their opinions on the methods used.....".

If older adults can be assisted in coping with their environment in all of its aspects, through the identification and practice of useful strategies for keeping memorial functions active, the quality of their lives may be increased along with longevity. If successful, these results will also be of benefit to young and middle-aged adults who will be able to look forward to a more rewarding life-span.

REFERENCES

Andre, T. (1979). Does answering higher-level questions while reading facilitate productive learning? Review of Educational Research, 49, 280-318.

Bartlett, F.C. (1932). Remembering. London: Cambridge University Press.

Boker, J.R. (1974). Immediate and delayed retention effects of interspersing questions in written intructional passages. Journal of Educational Psychology, 66 (1), 96-98.

Botwinick, J. (1978). Aging and behavior. New York: Springer.

Bovy, R.C. (1981). Successful instructional methods: A cognitive information processing approach. Educational Communication and Technology, 29, (4), 203-217.

Bransford, J.D., McCarrell, N.S., Franks, J.J., & Nitsch, K.E. (1977). Toward unexplaining memory. In R. Shaw & J. Bransford (Eds.), Perceiving, acting and knowing: Toward an ecological psychology. Hillsdale, N.J.: Lawrence Erlbaum.

Britton, B.K., Glynn, S.M., Meyer, B.J.F. & Penland, M.J. (1982). Effects of text structure on use of cognitive capacity during reading. Journal of Educational Psychology, 74, (1) 51-61.

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. American Psychologist, 32, 513-531.

Brooks, L.W., Dansereau, D.F., Spurlin, J.E. & Holley, C.D. (1983). Effects of headings on text processing. Journal of Educational Psychology, 75, (2), 292-302.

Brown, A.L. (1978). Knowing when, where, and how to remember: A problem of metacognition. In R. Glaser (Ed.), Advances in instructional psychology. Hillsdale, N.J.: Lawrence Erlbaum.

Bruce, J.A. & Cox, M.O. (1983). Metamemory and structure: Spelling. Educational Research Quarterly, 8, (2), 38-43.

Bruce, P.R., Coyne, A.C. & Botwinick, J. (1982). Adult age differences in metamemory. Journal of Gerontology, 37, (3), 354-357.

Cavanaugh, J.C. & Borkowski, J.G. (1979). The metamemory-memory "connection": Effects of strategy training and maintenance. The Journal of General Psychology, 101, 161-174.

Cavanaugh, J.C. & Perlmutter, M. (1982). Metamemory: A critical examination. Child Development, 53, 11-28.

Craik, F.I.M. (1977). Age differences in human memory. In J.E. Birren & K.W. Schaie (Eds.), Handbook of the psychology of aging. New York: Van Nostrand Reinhold Co.

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

Craik, F.I.M. & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology: General, 104, 268-294.

Davies, G.M. (1980). Can memory be educated? Educational Studies, 6 (2), 155-161.

Dixon, R.A. (1982). Structure and development of metamemory in adulthood. Unpublished doctoral dissertation, Pennsylvania State University.

Dixon, R.A. & Hultsch, D.F. (1983a). Structure and development of metamemory in adulthood. Journal of Gerontology, 38, (6), 682-688.

Dixon, R.A. & Hultsch, D.F. (1983b). Metamemory and memory for text relationships in adulthood: A cross-validation study. Journal of Gerontology, 38, (6), 689-694.

Dixon, R.A. & Hultsch, D.F. (1984). The metamemory in adulthood (M.I.A.) instrument, JSAS Catalog of Selected Documents in Psychology, 14, (1), 3. (Ms. No. 2605).

Dixon, R.A., Simon, E.W., Nowak, C.A. & Hultsch, D.F. (1982). Text recall in adulthood as a function of level of information, input modality, and delay interval. Journal of Gerontology, 37, (3), 358-364.

Doctorow, M., Wittrock, M.C., & Marks, C. (1978) Generative processes in reading comprehension. Journal of Educational Psychology, 70, (2), 109-118.

Ellis, J.A., Konoske, P.J., Wulfeck II, W.H. & Montague, W.E. (1982). Comparative effects of adjunct postquestions and instructions on learning from text. Journal of Educational Psychology, 74, (6), 860-867.

Flavell, J.H. (1971). First discussant's comments: What is memory development the development of? Human Development, 14, 272-278.

Flavell, J.H. & Wellman, H.M. (1977). Metamemory. In R.V. Kail, Jr., & J.W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Lawrence Erlbaum.

Glynn, S.M. & DiVesta, F.J. (1977). Outline and hierarchical organization as aids for study and retrieval. Journal of Educational Psychology, 69, (2), 89-95.

Glynn, S.M. & Muth, K.D. (1979). Test learning capabilities of older adults. Educational Gerontology, 4, 253-267.

Hale, G.A. (1983). Students' predictions of prose forgetting and the effects of study strategies. Journal of Educational Psychology, 75, (5), 708-715.

Hultsch, D.F. (1974). Learning to learn in adulthood. Journal of Gerontology, 29, (3), 302-308.

Hultsch, D.F. (1975). Adult age differences in retrieval: Trace dependent and cue dependent forgetting. Developmental Psychology, 11, 197-201.

Hultsch, D.F. & Dixon, R.A. (1984). Memory for text materials in adulthood. In P.B. Baltes & O.G. Brim, Jr. (Eds.), Life-span development and behavior, (Vol 6) New York: Academic Press.

Hultsch, D.F. & Pentz, C.A. (1980). Encoding, storage and retrieval in adult memory: The role of model assumptions. In L.W. Poon, J.L. Fozard, L.S. Cermak, D. Arenberg & L.W. Thompson (Eds.), New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference. Hillsdale, N.J.: Lawrence Erlbaum.

Hurst, B.M. (1980). An integrated approach to the hierarchical order of the cognitive and affective domaines. Journal of Educational Psychology, 72, (3), 293-303.

Jenkins, J.J. (1974). Remember that old theory of memory? Well, forget it. American Psychologist, 29, 785-795.

Jenkins, J.J. (1979). Four points to remember: A tetrehedral model of memory experiments. In L.C. Cermak & F.I.M. Craik (Eds.), Levels of processing in human memory. Hillsdale, N.J.: Lawrence Erlbaum.

Kintsch, W. (1977). Memory and cognition. New York: John Wiley & Sons.

Lachman, J.L., Lachman, R., & Thronesbery, C. (1979). Metamemory through the adult life span. Developmental Psychology, 15, (5), 543-551.

Lachman, J.L. & Lachman, R. (1980). Age and the actualization of world knowledge. In L.W. Poon, J.L. Fozard, L.S. Cermak, D. Arenberg, & L.W. Thompson (Eds.), New directions in memory and aging: Proceedings of the George A. Talland Memorial Conference. Hillsdale, N.J.: Lawrence Erlbaum.

Lovelace, E. (1982). Prediction and evaluation of memory performance by young and old adults. Boston, MA: (ERIC Document Reproduction Service No. ED 230 833).

Meyer, B.J.F. (1977). The structure of prose: Effects on learning and memory and implications for educational practice. In R.C. Anderson, R. Spiro, & W.E. Montagne (Eds.), Schooling and the acquisition of knowledge. Hillsdale, N.J.: Lawrence Erlbaum.

Meyer, B.J.F. & Rice, G.E. (1981). Information recalled from prose by young, middle, and old adult readers. Experimental Aging Research, 7, (2), 253-268.

Murphy, M.D., Sanders, R.E., Gabriesheski, A.S. & Schmitt, F.A. (1981). Metamemory in the aged. Journal of Gerontology, 36, (2), 185-193.

Nelson, M.J. & Denny, E.C. (1973). The Nelson-Denny reading test: Form C. Boston: Houghton Mifflin Co.

Norman, D.A. (1982). Learning and memory. San Francisco: W.H. Freeman.

O'Sullivan, J.T. (1983). The effectiveness of metamemory instruction in promoting generalization of the keyword mnemonic strategy: A development study. Unpublished doctoral dissertation, University of Western Ontario.

Overton, W.F. & Reese, H.W. (1973). Models of development: Methodological implications. In J.R. Nesselroade & H.W. Reese (Eds.), Life-span developmental psychology: Methodological issues. New York: Academic Press.

Perlmutter, M. (1978). What is memory aging the aging of? Developmental Psychology, 14, (2), 330-345.

Rickards, J.P. (1976). Interaction of position and conceptual level of adjunct questions on immediate and delayed retention of text. Journal of Educational Psychology, 68, 210-217.

Rickards, J.P. (1979). Adjunct postquestions in text: A critical review of methods and processes. Review of Educational Research, 49, (2), 181-196.

Rickards, J.P. & DiVesta, F.J. (1974). Type and frequency of questions in processing textual material. Journal of Educational Psychology, 66, (3), 354-362.

Romiszowski, A.J. (1984). Producing instructional systems. London: Kogan Page.

Rothkopf, E.Z. (1965). Some theoretical and experimental approaches to problems in written instruction. In J.D. Krumboltz (Ed.), Learning and the educational process. Chicago: Rand McNally & Co.

Rothkopf, E.Z. (1970). The concept of mathemagenic activities. Review of Educational Research, 40, (3), 325-336.

Rothkopf, E.Z. (1976). Writing to teach and reading to learn: A perspective on the psychology of written instruction. In N.L. Gage (Ed.), The psychology of teaching methods. Chicago: University of Chicago Press.

Rothkopf, E.Z. & Billington, M.S. (1974). Indirect review and priming through questions. Journal of Educational Psychology, 66, 669-679.

Rothkopf, E.Z. & Bisbicos, E. (1967). Selective facilitative effects of interspersing questions in learning from written materials. Journal of Educational Psychology, 58, 56-61.

Schaie, K.W. (1974). Translations in gerontology: From lab to life. American Psychologist, 29, 802-807.

Taub, H.A. (1976). Method of presentation of meaningful prose to young and old adults. Experimental Aging Research, 2, 469-474.

Taub, H.A. (1979). Comprehension and memory of prose materials by young and old adults. Experimental Aging Research, 5, 3-13.

Taub, H.A. (1980). Life-span education: A need for research with meaningful prose. Educational Gerontology, 5, 175-187.

Wagner, D.A. & Paris, S.G. (1981). Problems and prospects in comparative studies of memory. Human Development, 24, 412-424.

Wass, H. & Olejnik, S.F. (1983). An analysis and evaluation of research in cognition and learning among older adults. Educational Gerontology, 9, 323-337.

Winer, B.J. (1971). Statistical principles in experimental design. New York: McGraw Hill.

Wingfield, A. (1979). Human learning and memory: An introduction. New York: Harper & Row.

Zivian, M.T. & Darjes, R.W. (1983). Free recall by in-school and out-of-school adults: Performance and metamemory. Developmental Psychology, 19, (4), 513-520.

Appendix A

Pre-experimental Materials

A.1 Letter to prospective subjects

A.2 Consent and schedule preference

A.3 Instructions for identifying "idea units"

A.4 Intentional idea units

A.5 Incidental idea units

CONCORDIA UNIVERSITY

I agree to participate in the project described in the letter from Prof. F.D. Hamblin dated April 24, 1985, and hereby authorize Concordia University to release my name and telephone number to the graduate student conducting the research.

Signature _____

Name (Please print) _____

Telephone No. ____ - _____

My preference for the location, day and time of the sessions are indicated below.

Location (Campus): ☐ Loyola

☐ S.G.W.

☐ No Preference

	Time (Please check as many boxes as appropriate)			
Day	No Preference	9:30 a.m.- 11:30 a.m.	11:30 a.m.- 1:30 p.m.	1:30 p.m.- 3:30 p.m.*
No Preference	☐	☐	☐	☐
Monday	☐	☐	☐	
Tuesday	☐	☐	☐	
Wednesday	☐	☐	☐	
Thuraday	☐	☐	☐	
Friday	☐	☐	☐	
Saturday	☐	☐	☐	☐

* The time period 1:30 p.m. to 3:30 p.m. is available on Saturday only.

SIR GEORGE WILLIAMS CAMPUS
1455 DE MAISONNEUVE BLVD. WEST
MONTREAL, QUEBEC H3G 1M8

Instructions

In order to analyze the results of this study, it is necessary to divide the text on weather forecasting into "complete idea units".

An idea unit can consist of a complete sentence, a clause or a phrase. It carries a complete idea. Although an idea unit may rely on another idea unit for reference (e.g., when using pronouns such as "he", "her", "their", etc), an idea unit can normally stand on its own because it does convey a complete idea.

The procedure that you should use is as follows: as you read through the text, enclose each idea unit in parentheses ( ). If one idea unit is embedded within another, just use double parentheses. The following is an example of what you are being asked to do.

> (Aaron Burr, (alternately sentimentalized and pilloried by historians,) has had the last laugh at the expense of posterity.) (Many details of his life are still a mystery.) (Even the modern biographer must fit together the pieces of the puzzle, (knowing that some are still missing.)

You may have divided these sentences differently, so just consider what YOU think constitutes a complete idea. Please rate the entire text for idea units.

Intentional Idea Units

1. Hail, floods, freezes, lightning and hurricanes destroyed $27 billion in property, crops and livestock in the U.S. in 1983.
2. Four-day forecasts are now as accurate as two-day forecasts used to be.
3. In predictions of temperature a day ahead, the number of errors exceeding ten degrees Fahrenheit are half of what they were in the 1960s.
4. Precipitation forecasts are more accurate as well.
5. Among the most important advances is the global atmospheric model.
6. It is a computer simulation of the weather of the entire planet.
7. Weather results from intricate interactions throughout the troposphere.
8. Troposphere - the blanket of air that extends twelve miles up from the earth to the ozone layer.
9. Warm air ascends from the equator .....
10. It moves toward the poles to clash with vast cold fronts.
11. Small (micro scale) and/or medium (meso scale) forecasts cover areas up to 30 miles in diameter.
12. They take in single clouds, squall lines, tornados and tropical storms.
13. The synoptic scale takes in vast migratory storms .....
14. ..... tracked by means of observations .....
15. ..... made simultaneously over hundreds of square miles.
16. Solar energy heats the continents and the oceans.
17. Solar energy is converted by the atmosphere to a change in the motion (kinetic energy) of winds.

18. Modern forecasting centers have complex mathematical models at their cores.

19. They are run by the fastest computing machines in the world - the 1st generation of super computers.

20. As the Cray produces its vision of the meteorological future the process is put in reverse to disseminate predictions to local forecasters in Europe.

21. An abbreviated version goes to the NWS in Washington .....

22. Global models are too coarse .....

23. Global models cover too large an area to be useful to those who are interested .....

24. The process by which meteorologists gather data is like an enormous nervous system .....

25. ..... with a central forecasting center as the brain and ganglia that reach into the troposphere.

26. One of the largest gaps in the weather net lies over the oceans .....

27. ..... a crucial weakness in the data gathering system.

28. In huge expanses of the ocean, particularly the tropics, no one knows what happens.

29. The computer models resemble scaffolding .....

30. ..... that covers the entire globe up to the troposphere.

31. The model's calculations are based on interactions between cells .....

32. ..... exchanges of heat, changes in pressure and humidity.

33. Mathematicians are tinkering with fine grained global models at Boulder, Colorado and Princeton's Geophysical Fluid Dynamics Laboratory.

34. Global models will soon run on the next generation of super computers.

35. At PROFS, atmospheric measurements pour in ....,

36. ..... satellite images are beamed to Boulder every few minutes .....

37. A close knit network of ground stations send in readings from 100 miles around.

38. Results of this data deluge are remarkable .....

39. A fifteen to twenty percent increase in severs thunderstorm warnings .....

40. ..... within areas approximately half the size usually observed have been found.

41. The theoretical limit within which weather systems can be foretold accurately is about to weeks .....

42. ..... twice what is it today.

Incidental Idea Units

1. The stakes involved in reliable weather predictions are enormous.
2. In summer tornado warnings send people scrambling to their cellars.
3. In winter transportation departments depend on forecasts to dispatch crews.....
4. Foul weather closes highways .....
5. ..... shuts down airports .....
6. Sudden blasts of wind (microbursts) can knock planes out of the sky.
7. Seven hundred people died .....
8. 5,000 more were injured .....
9. In the past two winters cold snaps have cost Florida growers more than $2 billion in harvests.
10. Forecasters have achieved surprising precision in the past 20 years.
11. Much of the forecasters growing skill is the result of advances is their science.
12. Regional offices of the NWS are connected to the main terminal in Camp Springs, Maryland .....
13. It can call up large scale maps on their own screens .....
14. ..... superimpose local observations .....
15. ..... zoom in on up-to-date pictures of neighboring areas.
16. Future local forecasts will rely on techniques now in their rudimentary stages.
17. Weather is one of the most complicated problems in all science.
18. The most striking thing about the troposphere is that it moves .....
19. ..... and on a grand scale.

20. Hurricanes spin like pinwheels 400 miles across .....

21. ..... sucking up moisture from the oceans into their vortices.

22. These forces produce everything from rain in Spain to the sunny skies over southern California.

23. The scale of a forecast depends on the size of the atmospheric events it encompasses.

24. Small and medium range forecasts are extrapolated from satellite pictures and local observations .....

25. ..... they are the trickiest of all.

26. Small scale weather patterns can appear without warning.

27. The next larger scale (synoptic) comprises weather patterns hundreds of miles across.

28. Although as dangerous as mesoscale, synoptic patterns build up over longer periods.

29. Synoptic systems are controlled by the largest events of all .....

30. ..... collisions between masses of moving air that can cover a hemisphere.

31. They are governed by the driving force behind all weather - the sun.

32. To predict large scale weather patterns, meteorologists must measure the constantly changing conditions in the atmosphere.

33. The NMC uses a Cyber 205 at its global forecasting center in Maryland .....

34. ..... there are other global centers in Canada and Japan.

35. The most dazzling new model is in Reading, England .....

36. ..... home to the European Center for Medium Range Forecasts.

37. At Reading the best meteorologists from 17 countries use the biggest and fastest American built Cray X-MP .....

38. ..... to produce global forecasts 3 to 10 days in advance.

39. At the NMC the Cyber 205 produces forecasts up to five days in advance, twice daily .....

40. ..... and longer forecasts once a day.

41. ..... close to 500 maps .....

42. ..... reams of printout are issued by the center.

43. To illustrate what's happening in the troposphere .....

44. ..... swirling lines connect areas of similar barometric pressure .....

45. ..... another may show a cross section of wind speeds through a tropical storm .....

46. ..... a third may chart humidity at a given altitude around the globe.

47. Super computers manipulate equations covering the planet .....

48. ..... fitting the parts of the atmosphere together at the local level ought to be easy .....

49. ..... it isn't.

50. On the surface of North America, hundreds of ground stations measure humidity, rainfall, barometric pressure and temperature every one to three hours.

51. At sunrise and sunset radiosondes are released to sense the upper troposphere.

52. Two satellites circle the poles .....

53. ..... another pair hover over the equator above the Pacific and Atlantic .....

54. They beam down photographs and infrared measurements every half hour.

55. Daily 2000 observations from commercial pilots, Navy observers, severe-storm spotters, ham radio operators, and volunteers on ships are sent to the NWS.

56. About 100,000 separate measurements go into the NWS computer in Maryland every day.

57. This volume of information isn't enough.

58. Only recently do meteorologists understand that air and gases act as a single fluid .....

59. ..... exchanging air and gases.

60. The atmosphere is a problem because it is non-linear.

61. In a linear system, two horses can pull twice the load of one.

62. In the atmosphere one and one can add up to almost anything.

63. A misstep, such as neglecting to detect a small front ....

64. ..... can grow out of proportion as the model churns its way into next week.

65. Each cube in the three dimensional grid is called a cell.

66. In most models the cells are 100 to 200 miles on a side.

67. Even at Reading, the finest grain model, it is 75 miles.

68. If observations from a cell are missing, the model can be off by 75 miles.

69. The atmosphere changes so fast .....

70. ..... mesoscale forecasts may lost their credibility after just a few hours.

71. The new computer models are ten to fifteen times as powerful as today's.

72. The most productive of all experimental efforts is PROFS at Boulder, Colorado.

73. Meteorologists are working with researchers to make zero to twelve hour forecasts better.

74. PROFS predictions have been significantly more accurate than those of the NWS in Denver.

75. PROFS uses a new Doppler radar .....

76. ..... it tracks the direction of storms .....

77. ..... and measures how fast winds are moving within them.

78. Every 20 minutes PROFS gets temperature and humidity readings at different altitudes from a Profiler .....

79. ..... a ground based device to measure heat radiated from water molecules in the air.

80. Until PROFS are established around the country .....

81. ..... probably in the 1990s .....

82. ..... the NWS is souping up its existing stations.

83. By the 1990s an Automated Weather Information Processing System will assemble the information from .....

84. ..... ground stations, radiosondes, satellites and buoys into a single image on computer screens.

85. For all their hopes, meteorologists know they'll never have weather predictions licked.

86. Limitations don't dampen the enthusiasm of scientists .....

87. ..... for finding out why computers say one thing when weather does something else.

Appendix B

Experimental Materials

B.1 Metamemory in Adulthood

B.2 Attitude Statement

B.3 Instructions to strategy groups

B.4 Instructions to control groups

B.5 Experimental text with adjunct postquestions

B.6 Demographic questionnaire.

MEMORY QUESTIONNAIRE

Directions

Different people use their memory in different ways in their everyday lives. For example, some people make shopping lists, while others do not. Some people are good at remembering names, while others are not.

In this questionnaire, we would like you to tell us how you use your memory and how you feel about it. There are no right or wrong answers to these questions because people are different. Please take your time and answer each of these questions to the best of your ability.

Each question is followed by five choices. Draw a circle around the letter corresponding to your choice. Mark only one letter for each statement.

Some of the questions ask your opinion about memory-related statements: for example:

My memory will get worse as I get older.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

---

In this example you could, of course, choose any one of the answers. If you agree strongly with the statement you would circle a. If you disagree strongly you would circle letter e. The b and d answers indicate less strong agreement or disagreement. The letter c gives you a middle choice, but don't use the c unless you really can't decide on any of the other responses.

Some of the questions ask how often you do certain things that may be related to memory. For example:

Do you make a list of things to be accomplished during the day?	a. never b. rarely c. sometimes d. often e. always

Again, you could choose any <u>one</u> of the answers. Choose the one that comes closest to what you <u>usually</u> do. Don't worry if the time estimate is not exact, or if there are some exceptions.

<u>Keep these points in mind</u>

(a) Answer every question, even if it doesn't seem to apply to you very well.

(b) Answer as honestly as you can what is true for you. Please do not mark something because it seems like the "right thing to say".

1.	For most people, facts that are interesting are easier to remember than facts that are not.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
2.	I am good at remembering names.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
3.	Do you keep a list or otherwise note important dates, such as birthdays and anniversaries?	a. never b. rarely c. sometimes d. often e. always
4.	It is important to me to have a good memory.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
5.	I get upset when I cannot remember something.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
6.	When you are looking for something you have recently misplaced, do you try to retrace your steps in order to locate it?	a. never b. rarely c. sometimes d. often e. always
7.	How often do you visit places you have never been before?	a. about once a month or less b. about once a week c. about once a day d. about several times a day e. more than several times a day
8.	I think a good memory is something of which to be proud.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

9. I find it harder to remember things when I am upset.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
10. I am good at remembering birthdates.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
11. I can remember things as well as always.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
12. When you have not finished reading a book or magazine, do you somehow note the place where you have stopped?	a. never b. rarely c. sometimes d. often e. always
13. I get anxious when I am asked to remember something.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
14. It bothers me when others notice my memory failures.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
15. I'm less efficient at remembering things now than I used to be.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
16. I have difficulty remembering things when I am anxious.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
17. The older I get the harder it is to remember clearly.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

18. Do you think about the day's activities at the beginning of the day so you can remember what you are supposed to do?	a. never b. rarely c. sometimes d. often e. always
19. I am just as good at remembering as I ever was.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
20. I have no trouble keeping track of my appointments.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
21. For most people, it is easier to remember information they need to use immediately than information they will not use for a long time.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
22. Most people find it easier to remember directions to places they want or need to go than to places they know they will never be going.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
23. I am usually uneasy when I attempt a problem that requires me to use my memory.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
24. I feel jittery if I have to introduce someone I just met.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
25. Having a better memory would be nice but it is not very important.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
26. Do you post reminders of things you need to do in a prominent place, such as bulletin boards or note boards?	a. never b. rarely c. sometimes d. often e. always

27. It doesn't bother me when my memory fails.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
28. I am poor at remembering trivia.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
29. I am much worse now at remembering the content of news articles and broadcasts than I was 10 years ago.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
30. Do you routinely keep things in a familiar spot so you won't forget them when you need to locate them?	a. never b. rarely c. sometimes d. often e. always
31. Compared to 10 years ago, I am much worse at remembering titles of books, films, or plays.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
32. For most people it is easier to remember words they want to use than words they know they will never use.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
33. I remember my dreams much less now than 10 years ago.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
34. I can't expect to be good at remembering postal codes at my age.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
35. Most people find it easier to remember the names of people they especially dislike than people they hardly notice.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

36.	I have little control over my memory ability.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
37.	When you want to take something with you, do you leave it in an obvious, prominent place such as putting your suitcase in front of the door?	a. never b. rarely c. sometimes d. often e. always
38.	How often do you visit with family?	a. about once a month or less b. about once a week c. about once a day d. about several times a day e. more than several times a day.
39.	I think it is important to work at sustaining my memory ability.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
40.	I misplace things more frequently now than when I was younger.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
41.	As people get older they tend to forget where they put things more frequently.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
42.	I work hard at trying to improve my memory.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
43.	Compared to 10 years ago, I now forget many more appointments.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

44.	If I am put on the spot to remember names I know I will have difficulty doing it.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
45.	For more people, it is easier to remember the names of people they especially like than people that don't make much of an impression on them.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
46.	Most people find it easier to remember words they understand than words that don't mean very much to them.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
47.	My memory for important events has improved over the last 10 years.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
48.	I admire people who have good memories.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
49.	My friends often notice my memory ability.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
50.	When you try to remember people you have met, do you associate names and faces?	a. never b. rarely c. sometimes d. often e. always
51.	I am good at remembering the order that events occurred.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
52.	For most people, words they have seen or heard before are easier to remember than words that are totally new to them.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

53.	Familiar things are easier to remember than unfamiliar things.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
54.	I am good at remembering conversations I have had.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
55.	I would feel on edge right now if I had to take a memory test or something similar.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
56.	My memory for phone numbers will decline as I get older.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
57.	I often notice my friends' memory ability.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
58.	My memory for dates has greatly declined in the last 10 years.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
59.	When you have trouble remembering something, do you try to remember something similar in order to help you remember?	a. never b. rarely c. sometimes d. often e. always
60.	How often do you listen to music?	a. about one hour a month or less b. about one hour a week c. about one hour a day d. about several hours a day e. more than several hours a day

61.	My memory for names has greatly declined in the last 10 years.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
62.	I often forget who was with me at events I have attended.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
63.	Do you consciously attempt to reconstruct the day's events in order to remember something.	a. never b. rarely c. sometimes d. often e. always
64.	How often do you listen to the radio?	a. about one hour a month or less b. about one hour a week c. about one hour a day d. about several hours a day e. more than several hours a day
65.	As long as I exercise my memory it will not decline.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
66.	I am good at remembering the places I have seen.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
67.	I know if I keep using my memory I will never lose it.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
68.	Do you try to relate something you want to remember to something else hoping that this will increase the likelihood of your remembering later?	a. never b. rarely c. sometimes d. often e. always

69. It is important that I am very accurate when remembering names of people.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
70. When I am tense and uneasy at a social gathering I cannot remember names very well.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
71. Do you try to concentrate hard on something you want to remember?	a. never b. rarely c. sometimes d. often e. always
72. How often do you read newspapers?	a. about once a month or less b. about once a week c. about once a day d. about several times a day e. more than several times a day
73. It is important that I am very accurate when remembering significant dates.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
74. It is up to me to keep my remembering abilities from deteriorating.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
75. When someone I don't know very asks me to remember something I get nervous.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
76. I have no trouble remembering where I have put things.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

77. It is easier for most people to remember things that are unrelated to each other than things that are related.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
78. How often to you read non-fiction books?	a. about once a month or less b. about once a week c. about once a day d. about several times a day e. more than several times a day
79. Even if I work on it my memory ability will go downhill.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
80. Most people find it easier to remember concrete things than abstract things.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
81. Do you make mental images or pictures to help you remember?	a. never b. rarely c. sometimes d. often e. always
82. I know of someone in my family whose memory improved significantly in old age.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
83. I am good at remembering things like recipies.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
84. I get anxious when I have to do something I haven't done for a long time.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

85. It bothers me when I forget an appointment.
   a. agree strongly
   b. agree
   c. undecided
   d. disagree
   e. disagree strongly

---

86. How often do you read fiction books?
   a. about once a month or less
   b. about once a week
   c. about once a day
   d. about several times a day
   e. more than several times a day

---

87. Most people find it easier to remember things that happen to them than things that happen to others.
   a. agree strongly
   b. agree
   c. undecided
   d. disagree
   e. disagree strongly

---

88. Do you mentally repeat something you are trying to remember?
   a. never
   b. rarely
   c. sometimes
   d. often
   e. always

---

89. My memory has greatly improved in the last 10 years.
   a. agree strongly
   b. agree
   c. undecided
   d. disagree
   e. disagree strongly

---

90. How often do you read news magazines (such as Time)?
   a. about once a month or less
   b. about once a week
   c. about once a day
   d. about several times a day
   e. more than several times a day

---

91. I like to remember things on my own, without relying on other people to remind me.
   a. agree strongly
   b. agree
   c. undecided
   d. disagree
   e. disagree strongly

---

92. I get tense and anxious when I feel my memory is not as good as other peoples'.
   a. agree strongly
   b. agree
   c. undecided
   d. disagree
   e. disagree strongly

---

93. Do you ask other people to remind you of something?	a. never b. rarely c. sometimes d. often e. always
94. How often do you read non-news magazines?	a. about once a month or less b. about once a week c. about once a day d. about several times a day e. more than several times a day
95. I'm highly motivated to remember new things I learn.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
96. I do not get flustered when I am put on the spot to remember new things.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
97. I am good at remembering titles of books, films, or plays	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
98. My memory has greatly declined in the last 10 years.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
99. For most people it is easier to remember things in which they are most interested than things in which they are less interested.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
100. I have trouble remembering lyrics of songs.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

101. My memory will get better as I get older.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
102. It is easier for most people to remember bizarre things than usual things.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
103. Do you write yourself reminder notes?	a. never b. rarely c. sometimes d. often e. always
104. I am good at remembering names of musical selections.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
105. Most people find it easier to remember visual things than verbal things.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
106. After I have read a book I have no difficulty remembering factual information from it.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
107. Do you write appointments on a calendar to help you remember them?	a. never b. rarely c. sometimes d. often e. always
108. I would feel very anxious if I visited a new place and had to remember how to find my way back.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
109. I am good at remembering the content of news articles and broadcasts.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly

110. About how much time do you spend writing?
- a. about one hour a month or less
- b. about one hour a week
- c. about one hour a day
- d. about several hours a day
- e. more than several hours a day

---

111. No matter how hard a person works on his memory, it cannot be improved very much.
- a. agree strongly
- b. agree
- c. undecided
- d. disagree
- e. disagree strongly

---

112. If I were to work on my memory I could improve it.
- a. agree strongly
- b. agree
- c. undecided
- d. disagree
- e. disagree strongly

---

113. It gives me great satisfaction to remember things I thought I had forgotten.
- a. agree strongly
- b. agree
- c. undecided
- d. disagree
- e. disagree strongly

---

114. Remembering the plots of stories and novels is easy for me.
- a. agree strongly
- b. agree
- c. undecided
- d. disagree
- e. disagree strongly

---

115. I am usually able to remember exactly where I read or heard a specific thing.
- a. agree strongly
- b. agree
- c. undecided
- d. disagree
- e. disagree strongly

---

116. I think a good memory comes mostly from working on it.
- a. agree strongly
- b. agree
- c. undecided
- d. disagree
- e. disagree strongly

---

117. How often do you fill out forms, such as applications or income tax forms?
- a. about once a month or less
- b. about once a week
- c. about once a day
- d. about several times a day
- e. more than several times a day

---

118. How often do you go shopping?	a. about once a month or less b. about once a week c. about once a day d. about several times a day e. more than several times a day
119. Most people find it easier to remember unorganized things than organized things.	a. agree strongly b. agree c. undecided d. disagree e. disagree strongly
120. Do you write shopping lists?	a. never b. rarely c. sometimes d. often e. always

The results of recent research from educators and psychologists interested in adult development throughout the life-span have shown that older adults are capable of remembering almost as well as their younger counterparts.

The myth that memory failure increases dramatically with age stems from the psychological literature, and is based upon word-list studies, speed of recall and nonsense syllables. In recent years psychologists have begun to question whether the results of these studies are valid. Recent studies have indicated that perceived memory loss in older adults is more a function of attitude than physiological factors.

As a matter of fact, some scientists now think that many older adults can perform better, on some tasks, than those who are younger. It appears to depend on the development of a positive attitude toward the ability to remember, so that all of an adult's past experience and knowledge can be integrated with the new material being learned.

The following text is adapted from a recent magazine article on weather forecasting.

Please read it carefully. After each two paragraphs there are two questions relating to the material you have just read. Use these questions to assure yourself that you understand the passage. When you are certain that you know the answers, proceed to the next two paragraphs. Use this method to study the entire text. Please do not respond to the questions in writing, or make any notes as you read. You may take as much time as you wish, and you may re-read as often as you wish.

When you think that you are familiar with the material, please indicate to the investigator that you are ready for the next task.

The following text is adapted from a recent magazine article on weather forecasting.

Please read it carefully. You may take as much time as you wish, and you may re-read as often as you wish. Please do not make any notes as you read.

When you think that you are familiar with the material, please indicate to the investigator that you are ready for the next task.

Forecasting: How Exact Is It?

The stakes involved in reliable weather prediction are enormous. Every summer tornado warnings send people scrambling for the safety of their cellars, and, in winter transportation departments depend on forecasts to dispatch road crews during blizzards. Foul weather closes highways and shuts down airports, and sudden blasts of wind called microbursts can even knock planes out of the sky. Hail, floods, freezes, lightning, and hurricanes destroyed $27 billion in property, crops, and livestock in the U.S. in 1983. Seven hundred people died, and 5,000 more were injured. In the past two winters, cold snaps have cost Florida growers more than $2 billion in lost harvests.

Forecasters have achieved a surprising degree of precision in the past 20 years. Four-day forecasts are now as accurate as two-day forecasts used to be. In predictions of temperatures a day ahead, the number of errors exceeding ten degrees Fahrenheit are half of what they were in the 1960s, and precipitation forecasts are more accurate as well.

> Why are precise weather predictions essential?
>
> In what ways have weather reports improved in recent years?

Much of the forecasters' growing skill is a result of advances in their science. Among the most important is the global atmospheric model, a computer simulation of the weather of the entire planet. Regional offices of the National Weather

Service (NWS) are connected to the main computer in Camp Springs, Maryland, and can call up large-scale maps on their own screens, superimpose local observations, and zoom in on up-to-date pictures of neighboring areas. Local forecasts of the future will rely increasingly on techniques that are in their rudimentary stages today.

Weather is one of the most complicated problems in all of science. It results from intricate interactions throughout the troposphere, the blanket of air that extends twelve miles up from the earth to the ozone layer. The most striking thing about the troposphere is that it moves, and on a grand scale. Warm air ascends from the equator and moves toward the poles to clash with vast cold fronts. Hurricanes spin like colossal pinwheels 400 miles across, sucking up moisture from the oceans into their vortices. These forces ultimately produce everything from the rain in Spain to the sunny skies over southern California.

How have advances in technology aided meteorologists?
How do weather patterns develop?

The scale of a forecast depends on the size of the atmospheric events it encompasses. Small (micro) scale and medium (meso) scale forecasts cover areas up to 30 miles in diameter, and take in single clouds, squall lines, tornadoes, and tropical storms. These forecasts, largely a matter of extrapolating from satellite pictures and local observations, are the

trickiest of all, because weather patterns on such a small scale can appear without warning.

The next larger scale (synoptic) comprises weather patterns hundreds of miles across. The synoptic scale takes in vast migratory storms, like hurricanes, which are tracked by means of observations made simultaneously over hundreds of square miles. Although they can be just as dangerous as storms of the mesoscale, synoptic patterns generally build up over longer periods of time.

What factors limit local weather predictions? How do weather samples using greater distances differ from the regional variety?

Synoptic scale weather systems are controlled by the largest events of all, collisions between masses of moving air that can cover a whole hemisphere. They are governed by the driving force behind all weather - the sun. Solar energy, which heats the continents and the oceans, is converted by the atmosphere to a change in the motion (kinetic energy) of winds.

To predict large scale weather patterns, meteorologists must measure the constantly changing conditions in the atmosphere. Modern forecasting centers have, at their cores, complex mathematical models being run by the fastest computing machines in the world, the first generation of super-computers. The National Meteorological Center (NMC) uses a Cyber 205 at its global forecasting center in Maryland, and there are other

global centers in Canada and Japan. The most dazzling of the new mathematical models is in Reading, England, home to the European Centre for Medium Range Forecasts. At Reading, the best meteorologists from 17 countries use the biggest and fastest super-computer, the American built Cray X-MP, to produce global forecasts three to ten days in advance.

How does the sun influence atmospheric changes?

What part do simulations play in anticipating weather patterns?

As the Cray produces its vision of the meteorological future, the whole process must be put in reverse to disseminate the predictions to local forecasters in Europe. An abbreviated version goes to the NWS in Washington. At Reading's American counterpart, the NMC, the Cyber 205 produces forecasts up to five days in advance twice daily, and longer forecasts once a day. In all, close to 500 maps, and reams of printout are issued by the center. To illustrate what's happening in the troposphere, swirling lines connect areas of similar barometric pressure on one map; another may show a cross-section of wind speeds through a tropical storm; a third may chart the humidity at a given altitude around the globe.

With super computers manipulating equations covering the whole planet, fitting the parts of the atmosphere together at the local level ought to be easy. It isn't. For one thing, global models are too coarse, and cover too large an area to

be really useful to those who are interested in whether it's going to rain on tomorrow's parade.

> What is the relationship of a model's simulated prediction to an actual report of anticipated weather?
>
> What hinders meteorologists' ability to forecast on a local level?

The process by which meteorologists gather data is like an enormous nervous system, with a central forecasting center as the brain and ganglia that reach far into the troposphere. On the surface of North America alone, hundreds of ground stations measure humidity, rainfall, barometric pressure, and temperature every one to three hours. At sunrise and sunset NWS scientists release balloons with small radio transmitters (radiosondes) to sense the upper troposphere. Two satellites circle the poles, and another pair hover over the equator above the Pacific and the Atlantic, beaming down photographs and infrared measurements every half hour. Daily, some 2,000 observations from commercial pilots, Navy observers, severe-storm spotters, ham radio operators, and volunteers on ships are sent to the NWS. About 100,000 separate measurements go into the NWS computer in Maryland every day.

This volume of information isn't enough, however. One of the largest gaps in the weather net lies over the oceans, a crucial weakness in the data gathering system. Only recently have meteorologists begun to understand that the air and the oceans act almost as a single fluid, exchanging air and gases.

However, in huge expanses of the ocean, particularly in the tropics, no one knows what happens.

> How do scientists transfer assorted bits of information into weather predictions?
>
> With so much knowledge at their disposal, why can't meteorologists produce an accurate forecast?

The atmosphere itself is also a problem because its behavior is non-linear. In a linear system, two horses can pull twice the load of one. But in the atmosphere, one and one can add up to almost anything, and the slightest misstep, such as neglecting to detect a small front, can grow out of proportions as the model churns its way into next week.

The computer models resemble scaffolding that covers the entire globe, up to the top of the troposphere. Each cube in this giant three-dimensional grid is called a cell. In most models the cells are 100 to 200 miles on a side; even at Reading, which has the finest-grained model of all, it's still 75 miles. The model's calculations are based on the interactions between cells - exchanges of heat, changes in both pressure and humidity. If observations from a cell are missing, the model can be off by at least 75 miles. The atmosphere itself changes so fast that mesoscale forecasts may lose their credibility after just a few hours.

> How do mathematical prototypes measure the forces that determine weather?
>
> How do missing data affect a forecast?

On the theoretical front, mathematicians at the National Center for Atmospheric Research in Boulder, Colorado, and Princeton's Geophysical Fluid Dynamics Laboratory are tinkering with fine-grained global models that will soon run on the next generation of super computers, ten to fifteen times as powerful as today's.

The most productive of all the experimental efforts is the Program for Regional Observing and Forecasting Services (PROFS) at Boulder, Colorado. Here, working meteorologists and researchers have joined forces to make zero-to-twelve hour forecasts better. So far, PROFS's predictions have been significantly more accurate than those of the NWS in Denver. Atmospheric measurements pour into PROFS at an incredible clip; satellite images are beamed to Boulder every few minutes. A close-knit network of ground stations send in readings from 100 miles around. PROFS also uses a new Doppler radar, which not only tracks the directions of storms, but also measures how fast winds are moving within them. Every 20 minutes PROFS gets temperature and humidity readings at different altitudes from a Profiler, a ground-based device that measures heat radiated from water molecules in the air.

What newer concepts will be linked together in experimental models that are now being developed?

How will new technologies contribute to forecasts in the future?

The results of this deluge of data are remarkable. A fifteen to twenty percent increase in severe thunderstorm warnings, within areas that are approximately half the size usually observed, have been found. Until centers like PROFS are established around the country, probably in the 1990s, the NWS is souping up its existing stations. By the 1990s an Automated Weather Information Processing System will assemble information from many sources; ground stations, radiosondes, satellites, and buoys, into a single image on computer screens.

For all their great hopes, meteorologists know they'll never have weather prediction licked. The theoretical limit within which weather systems over most of the globe can be foretold accurately is about two weeks, twice what it is today. Yet, such limitations don't dampen the enthusiasm of scientists for finding out why their computers say one thing when the weather does something else.

What has caused the improvements found in recent forecasts?

When all of the new technologies are in place, what kind of weather prediction accuracy can we expect?

"Shannon Brownlee (c)
DISCOVER Magazine 4/85,
Time Inc."

BACKGROUND INFORMATION

AGE _____ SEX _____

NUMBER OF YEARS OF SCHOOLING _____

STUDENT STATUS:

- Graduate _____
- Undergraduate _____
- Independent _____

Compared with other people your age, how would you rate your:

GENERAL HEALTH:

- Very good _____
- Good _____
- Moderately good _____

EYESIGHT:

- Very good _____
- Good _____
- Moderately good _____

HEARING:

- Very good _____
- Good _____
- Moderately good _____

IS YOUR ACADEMIC BACKGROUND IN:

- Arts _____
- Science _____
- Both _____

Appendix C

Raw Data

C.1 Instructions for scoring the recall protocols

C.2 Raw scores

Instructions For Scoring the Recall Protocols

The enclosed list contains the intentional and incidental idea units that you identified from the weather forecasting text. The final list was agreed on by a majority of the raters.

Any other ideas recalled by the subjects and not mentioned in the text are called "intrusions". Divide the intrusions into idea units also.

Editorial comment about the text difficulty, etc., does not have to be considered.

Please separate the intentional, incidental and intrusion idea units in the subjects' responses. Gist recall is acceptable as long as the idea is there. Note the units in any way that is convenient for you. I need the total number of each type of idea unit, one set from the immediate recall (I), and one set from the delayed recall (II).

Example:

Subject No - 80-A

Immediate (I)

Intentional	10
Incidental	16
Intrusion	07

Delayed (II)

Intentional	08
Incidental	19
Intrusion	11

Treatment Group - 1

Adjunct Postquestions and Attitude Statement

Subject No.	Immediate Intentional	Delayed Intentional	Immediate Incidental	Delayed Intentional	N-D Comp.	N-D Reading Rate
01	03	03	08	06	03	143
02	09	04	08	04	15	182
03	04	02	03	04	10	278
04	12	08	18	13	17	230
05	05	06	10	10	19	230
06	09	06	14	07	10	252
07	10	08	25	24	13	207
08	11	05	05	03	17	241
09	10	10	09	09	19	278
10	01	99	05	99	13	170
11	10	09	05	10	20	291
12	07	04	11	12	08	219
13	10	07	08	12	13	170
14	12	15	11	10	29	357

Note: 99 = missing data

Treatment Group - 2

Adjunct Postquestions

Subject No.	Immediate Intentional	Delayed Intentional	Immediate Incidental	Delayed Incidental	N-D Comp	N-D Reading Rate
01	02	99	04	99	16	230
02	01	02	02	07	12	241
03	04	04	12	12	15	291
04	07	05	10	12	19	278
05	05	05	06	04	19	143
06	08	05	10	06	21	241
07	11	10	07	10	24	230
08	04	03	04	06	30	561
09	12	14	23	23	15	155
10	03	04	09	03	13	230
11	00	00	01	01	12	430
12	09	11	11	14	26	337
13	09	08	02	03	17	230

Note: 99 = missing data

Treatment Group - 3

Read-only Control

Subject No.	Immediate Intentional	Delayed Intentional	Immediate Incidental	Delayed Intentional	N-D Comp.	N-D Reading Rate
01	06	04	14	11	16	155
02	04	03	06	06	12	230
03	02	00	02	03	18	155
04	02	01	08	04	11	207
05	05	01	06	03	15	357
06	06	04	18	18	20	291
07	09	05	15	10	30	325
08	01	02	14	10	08	266
09	02	01	09	07	08	195
10	01	01	00	00	12	364
11	10	06	12	16	11	170
12	13	08	30	20	27	291
13	05	05	10	10	23	278
14	00	00	06	01	30	409

Note: 99 = missing data

Appendix D

Data from Dixon's (1982) Study

Table 13

Reliabilities, Means, and Standard Deviations of MIA Factored Subscales for Young (n = 48), Middle-Age (n = 50), and Old (n = 50) Adults, and Collapsed Across All Ages (n = 148) in Study 3

Scale	Coefficient α				Mean				Standard Deviations				Possible Scoring Range	No. of Items
	Y	MA	Old	All	Y	MA	Old	All	Y	MA	Old	All		
Strategy	.81	.84	.87	.85	68.2	66.3	64.9	66.5	8.8	10.3	11.5	10.3	18-90	18
Task	.84	.78	.78	.83	68.7	66.9	61.5	65.7	6.4	6.1	6.6	7.1	16-80	16
Capacity	.86	.84	.86	.86	58.6	56.5	53.6	56.2	10.6	10.0	10.3	10.5	17-85	17
Change	.82	.91	.90	.91	63.5	53.6	46.3	54.3	8.5	13.3	11.5	13.3	18-90	18
Activity	.45	.52	.46	.49	23.9	25.3	23.6	24.3	3.4	3.7	3.9	3.8	12-60	12
Anxiety	.82	.85	.82	.83	43.8	44.8	46.5	45.0	9.1	10.0	8.4	9.2	14-70	14
Achievement	.80	.84	.61	.79	60.4	60.8	62.5	61.2	7.8	9.1	5.5	7.7	16-80	16
Locus	.80	.74	.71	.77	36.0	34.2	30.9	33.6	4.3	4.9	4.8	5.1	9-45	9
Total Scale	.87	.88	.88	.89	423.0	408.3	389.9	406.8	28.8	32.6	30.5	33.5	120-600	120

Table 14

Correlations Among Factored Subscales for Young, Middle-Age, Old, and All Subjects in Study 3

			Strategy						
			1	2	3	4	5	6	7
Task	2	Young	.39						
		MA	.43						
		Old	.53						
		All	.46						
Capacity	3	Young	-.05	.23					
		MA	-.38	.22					
		Old	-.13	.08					
		All	-.16	.19					
Change	4	Young	.21	.40	.33				
		MA	-.16	.14	.60				
		Old	-.20	-.19	.80				
		All	-.01	.28	.59				
Activity	5	Young	.10	-.14	.17	-.10			
		MA	-.19	.00	.55	.35			
		Old	.33	.29	.19	.19			
		All	.09	.10	.30	.16			
Anxiety	6	Young	.17	-.17	-.53	-.43	-.04		
		MA	.38	.10	-.56	-.49	-.49		
		Old	.06	.05	-.37	-.49	-.08		
		All	.19	-.06	-.50	-.46	-.22		

Table 14 (Continued)

			Strategy						
			1	2	3	4	5	6	7
Achievement	7	Young	.33	.33	.40	.16	.09	.12	
		MA	.45	.48	.03	.01	-.07	.52	
		Old	.38	.22	.39	.19	.03	.10	
		All	.36	.26	.21	.02	-.01	.30	
Locus	8	Young	.12	.48	.41	.40	.07	-.19	.50
		MA	.35	.34	.23	.31	.17	.05	.43
		Old	.22	.18	.54	.55	.31	-.25	.39
		All	.27	.44	.43	.53	.20	-.15	.34

Table 20

Correlations of MIA Subscales with Memory for Text Performance by Age on Three Occasions of Measurement in Study 3

		Memory for Text (Occ. 1)	Memory for Text (Occ. 2)	Memory for Text (Occ. 3)
1. Strategy	Young	.21	.11	.09
	MA	.42*	.42*	.46*
	Old	.35*	.46*	.50*
	All	.33*	.30*	.31*
2. Task	Young	.33*	.35*	.38*
	MA	.23	.24	.14
	Old	.35*	.46*	.48*
	All	.44*	.47*	.45*
3. Capacity	Young	.38*	.40*	.34*
	MA	-.11	-.17	-.22
	Old	-.12	-.03	-.15
	All	.13	.16*	.12
4. Change	Young	.33*	.28*	.35*
	MA	-.08	-.07	-.07
	Old	-.17	-.11	-.14
	All	.23*	.27*	.30*
5. Activity	Young	.05	.06	-.10
	MA	-.08	-.10	-.05
	Old	.21	.23	.18
	All	.06	.05	.01
6. Anxiety	Young	-.38*	-.37*	-.33*
	MA	.09	.05	.05
	Old	-.10	-.22	-.06
	All	-.14	-.17*	-.15*
7. Achievement	Young	.26*	.24	.23
	MA	.15	.10	.04
	Old	.26*	.20	.24
	All	.13	.07	.05
8. Locus	Young	.31*	.28*	.30*
	MA	.29*	.19	.17
	Old	-.05	.04	.09
	All	.35*	.37*	.38*
9. Total	Young	.37*	.35*	.35*
	MA	.22	.16	.13
	Old	.03	.07	.04
	All	.35*	.36*	.35*

*$p < .05$