MEMORY PERCEPTIONS AND MEMORY PERFORMANCE IN OLDER ADULTS

by

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ABSTRACT

The possibility that memory performance decrements in older persons may be related to subjective knowledge and perceptions about memory was investigated in a sample of 185 male and 191 female, community-dwelling volunteers aged 54-93. This subjective information, often termed "metamemory", was assessed using the Metamemory in Adulthood (MIA) questionnaire which measures strategy use, knowledge of task demands and memory capacity, perceptions of memory as stable or subject to change, and memory-related state anxiety, achievement motivation and locus of control. Nine memory tests, adapted for use with older persons, were employed. MIA administration order was varied to determine the influence of having just completed memory tests on perceptions. No order effects were found. Significant age differences were found on perceptions of change and on achievement motivation. Anxiety and Change were the best predictors of performance, a finding discrepant with earlier work. Some evidence is provided for domain-specificity in metamemory/memory relationships, and for differences between late middle-aged adults and individuals in their 80s and 90s.

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CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

I. Memory and Aging

Many older people have the feeling that their memory is not as good as it used to be. The investigation of such feelings and other age-related differences in objective memory capacity has become a major focus of psychological aging research (Poon, 1985). Contrary to widely held stereotypes, developmental studies do not tend to report a global decline in memory functioning with age (Craik, 1977). Rather, the frequently observed memory deficits seem to be a function of several of variables including age, the type of task undertaken, the particular memory skill used, and various subjective characteristics of the individual.

Primary memory (Waugh & Norman, 1965) and tertiary memory, for instance, seem to be relatively unaffected by age (Craik, 1977; Erber, 1981). On the other hand, secondary memory shows comparatively large age differences (Craik, 1977; Smith, 1980); older individuals show poorer performance than younger people both at encoding stimulus information (Hultsch, 1971) and in retrieving it later

(Schonfield & Robertson, 1966).

Traditional views have suggested that age-related performance decrements are a function of inevitable, universal, age-related declines in basic memory processes. However, a considerable amount of variability in age differences has been found with secondary memory tasks (Poon, 1985). For example, although age decrements are typically present when the task demands spontaneous organizational and elaborative processing, the magnitude of such decrements can be reduced and sometimes eliminated through facilitating organizational and elaborative processing, and providing more familiar stimuli, more practice, and self-regulation of pace and methods of learning (Poon, 1985).

II. **Metamemory and Aging**

More recently, gerontologists have also begun to emphasize the potential role of meta-cognitive processes in age differences in memory functioning (e.g., Cavanaugh & Perlmutter, 1982; Dixon & Hultsch, 1983b; Flavell, 1971; Herrmann, 1982; Jenkins, 1979). This view suggests that individuals' performance may be shaped not only by their actual skills but also by their understanding of the cognitive demand characteristics of the situation and their perception of the likely outcomes of their behavior in such a situation (Hultsch, Hertzog & Dixon, in press). Such knowledge and perceptions have been termed "metamemory" (Flavell, 1971), and investigators studying metamemorial processes seek to use individuals' self-reports of their behavior in memory-related situations to help explain memory performance. This argument does not deny the existence of age-related changes in underlying memory processes, but suggests that people's perceptions of their own memory may also contribute to those changes.

Metamemory and aging work is based on three general assumptions: (a) that an individual's knowledge, beliefs and feelings about memory may play a role in performance in memory-demanding situations; (b) that such information may become more salient in later life; and (c) that it may contribute to the frequently observed differences in performance between younger and older adults (Dixon, 1985).

Early empirical work has found age differences on some metamemory dimensions (Dixon & Hultsch, 1983b; Hultsch, Hertzog & Dixon, in press; Zelinski, Gilewski & Thompson, 1980), and on some metamemory/memory task performance relationships (Chaffin & Herrmann, 1983; Dixon & Hultsch, 1983a; Dixon, Hertzog & Hultsch, 1986; Zelinski et al., 1980). Some domain specificity in relationships has also been observed in studies using text recall and traditional laboratory tasks (Dixon & Hultsch, 1983a; Dixon, Hertzog & Hultsch, 1986).

Despite these preliminary results, however, the elusive metamemory/memory relationship has already yielded inconsistencies between studies (Hultsch, Hertzog & Dixon, in press). Undoubtly, some part of this lack of congruence stems from a failure to converge on a circumscribed theoretical definition and a facilitative operational definition of metamemory. As Herrmann (1982) notes, Flavell's (1971; Flavell & Wellman, 1977) initial conceptualization sparked development of a plethora of instruments that have yielded provocative results, but that lacked the acceptable psychometric credibility needed to ensure validity. Flavell postulated three classes of knowledge: (a) knowledge about the memory demand characteristics of particular tasks or situations, (b) knowledge of potentially employable strategies relevant to a given task or situation and (c) memory relevant characteristics of the person him/herself (Flavell & Wellman, 1977). Early work focused largely on the first two of these three classes.

Dixon and Hultsch (1983b) have also provided a definition of metamemory which incorporates Flavell's first two classes of knowledge and further differentiates Flavell's third class. They defined metamemory as one's knowledge as well as subjective perceptions and beliefs about the functioning, development, capacities and uses of both one's own memory and the human memory system in general. They have operationalized it using the Metamemory In Adulthood (MIA) questionnaire which contains seven subscales: Knowledge of Memory Tasks (Task), Use of Memory Strategies (Strategy), Knowledge of One's Own Memory Capacities (Capacity), Attitudes Toward One's Own Memory: Perception of Change (Change), Memory and Achievement Motivation (Achievement), Memory and State Anxiety (Anxiety) and Locus of Control in Memory Abilities (Locus). Preliminary evidence suggests that these subscales are internally consistent and factorially valid (Dixon & Hultsch, 1983b). Although some of the areas tapped by these subscales resemble subscales on other metamemory instruments, the MIA is unique in considering memory-related affect, represented by the Anxiety, Achievement and Locus subscales.

Inconsistencies have still emerged, however, over several uses of the MIA. Previously observed age-related (and sex) differences on the MIA beg replication, and age-related differences in the salience of metamemory predictors require definitive demonstration. Furthermore, the general approach to the measurement of memory beliefs and perceptions as though they were trait-like characteristics of the individual also requires examination. There is some speculation that some aspects of metamemory may be more state-like, and therefore subject to short term fluctuations as a function of other labile characteristics such as affective state, fatigue, and health (Dixon, 1985; Hultsch, Dixon & Hertzog, 1985). If this is true, then the timing of the questionnaire administration within a particular testing session is potentially important. This issue is alluded to by Perlmutter (1978, pg. 333), but otherwise has not been considered in previous empirical work.

Specifically, then, the present research addresses the following three questions: (a) Are there robust age-related differences and sex differences in metamemory as measured by the Metamemory In Adulthood Questionnaire (Dixon & Hultsch, 1983b); (b) are there relationships between memory knowledge, beliefs, and affects and actual memory performance in multiple domains; and (c) is there a difference between groups who are given the MIA before taking a battery of memory tests and those who receive it afterward? Age differences are hypothesized on the MIA measures of Capacity and Change and on memory-related affect. Moderate correlations between the MIA Task and Strategy subscales and memory performance are predicted. No difference between the groups receiving the MIA before the memory tests and those receiving it afterward is expected.

CHAPTER 2

REVIEW OF THE LITERATURE

Metamemory research presumes that memory is amenable to self-report. Ideally, this report captures, reasonably accurately, knowledge, perceptions, beliefs and feelings about memory. Presumably, such expressions have some relationship to observable memory performance.

The present chapter addresses these assumptions. Following a review of metamemory's historical roots, a discussion of current conceptualizations of metamemory will be presented. Methodological issues will be considered next followed by a summary of empirical research on age differences in metamemory, the metamemory/memory performance relationship, and the issue of the lability of memory perceptions.

I. Influences on the Beginning of Metamemory Study

1. Changes in Approach to the Study of Cognition

Reviews of the literature from the 1950s to the 1980s reflect the zeitgeist of memory research (Poon, 1985). For example, researchers of the 1950s were strongly influenced by the traditional learning theorists (e.g., Hull, 1943; Skinner, 1938; Tolman, 1932) who believed that general laws could be found and applied uniformly and universally across all kinds of learning and all kinds of species and age groups. Children were believed to learn by the same rules as adults, and a child's knowledge base was thought to grow as associations between stimuli and responses accumulated.

In contrast, in the 1960s, the popularity of general learning theories waned; learning experiments seemed artificial and failed to address developmental questions (Stevenson, 1970; White, 1970). Instead, researchers began considering the development of activities and strategies initiated by the individual, such as rehearsal, categorization, and elaboration. Recognizing the importance of context, they used meaningful, organized stimulus materials like sentences, stories, and picture sequences instead of nonsense syllables. They posed questions about the organization of materials, the compatibility of new information with information already in the knowledge base, and the means of encoding, storing, and retrieving information (Brown, Bransford, Ferrara & Campione, 1983).

The information processing approach dominated the 1970s as investigators attempted to define and describe specific stages and stores of information flow. Results, however, were surrounded by a host of qualifications (e.g., Cermak & Craik, 1979). As Jenkins (1979) notes, research reports were filled with provisos about particular experimental paradigms, with limitations concerning the kinds of materials employed, with cautions concerning the strategies used by subject populations and with disclaimers relating to particular dependent measures.

In the 1980s, investigators are becoming more cognizant of the multidimensional nature of memory. They no longer search for universal laws. Instead, they look for interactions among factors, and have begun considering the influence of subjective factors since it appears that to be an effective memorizer, one must know something about his/her memory (Brown et al., 1983; Flavell, 1971; Flavell

& Wellman, 1977; Jenkins, 1979).

These changes in approach, then, provided some impetus to the study of metacognition and metamemory (Flavell, 1970). Other roots include introspection, memory theory, computer simulation and memory monitoring work, and memory strategy development research (Cavanaugh & Perlmutter, (1982).

2. Influences from Related Cognitive Work

Introspection. Memory self-reporting in some ways resembles early 20th century introspection techniques. Introspectionists sought to understand the processes of awareness involved in cognition by eliciting self-reports of experience from subjects (Cavanaugh & Perlmutter, 1982). These techniques, however, were criticized because the object of introspections was imprecisely defined, and because reports could not be quantified, validated or replicated.

Despite these problems, similar methods are still being used today in personality, psychophysical, clinical, attitude and metamemory research, and similar problems are incurred. One difference, though, is that whereas introspectionists wanted reports of the step-by-step execution of contemporaneous cognitive processes, metamemory researchers seek commentary on processes that have already happened or activities that the individual generally performs.

<u>Memory Theory</u>. Metamemory has been implicated, though not explicitly named, in several contemporary theories of memory (Cavanaugh & Perlmutter, 1892). According to a levels of processing framework (Craik & Lockhart, 1972), for example, while "deep processing" is more likely when incoming information is compatible with an individual's existing knowledge structures, the subject's biases, mnemonic strategies, and knowledge about retrieval (Bransford, Franks, Morris & Stein, 1979) also may play an important role.

Contextual memory researchers (e.g., Bartlett, 1932; Jenkins, 1974, 1979) also implicitly consider metamemory. For instance, Jenkins' (1979) tetrahedral model suggests that four classes of variables may interact to contribute to performance. These include: (a) orienting tasks (e.g., rehearsal, elaboration), (b) stimulus materials (e.g., modality, physical structure), (c) criterial tasks (e.g., recognition, recall) and (d) subject characteristics (e.g., memory skills, knowledge and attitudes).

Computer Simulation and Memory Monitoring. Artificial intelligence researchers have developed systems in which a "cognizer" monitors ongoing thinking, generates new knowledge and restructures existing information to aid future cognition (e.g., Bobrow & Collins, 1975; Klahr & Wallace, 1976). Such work suggests that prior knowledge about cognition is an important determinant of the nature of current thinking. Executive processes, or the mechanisms that orchestrate cognition (Neisser, 1967), are supposedly fueled by inferences generated on the basis of existing knowledge. Evidence for a "cognizer" that can keep track of or monitor ongoing thinking is provided by work on the feeling-of-knowing and the tip-of-the-tongue phenomenon (Brown & McNeill, 1966; Freedman & Landauer, 1966; Hart, 1965).

Memory Strategy Development Research. The most direct influence on the beginning of metamemory study was a discovery that immature and mature memorizers differed in spontaneous use of memory strategies (Brown, 1975; Flavell, 1977). Young children appeared to be unable to use strategies as a bridge to a memory problem solution. Flavell, Beach and Chinsky (1966) distinguished two possible sources of difficulty: (a) a mediational deficiency (Reese, 1962) wherein the would-be mediator is generated yet fails to mediate, or (b) a production deficiency wherein a mediator is not generated at all. In tests of serial recall, kindergarten children were found to show a production deficiency compared to third or fifth grade children.

Interestingly, children could use strategies when instructed to do so, but tended to abandon them when use was no longer required (Keeney, Cannizzo & Flavell, 1967). This insight instigated a search for the critical set of variables that underlie spontaneous strategy use.

Haith (1971) suggested that a child's general level of cognitive development affects all memory processes. Corsini (1971) felt that what a child will do in a given memory task situation depends on the nature of the task, the individual's experience with memory tasks and the individual's level of cognitive competence. Flavell (1971) postulated that memory development may proceed at two levels: (a) acquisition of skills and abilities, and (b) the development of an awareness of oneself as an active deliberate storer and retriever of information. He believed that with age children become more knowledgeable about their own mnemonic processes, capabilities and contents. Flavell (1971) then concluded that memory development involved the development of structuring and storing of input, of search and retrieval operations, and of monitoring and knowledge of these storage and retrieval operations. He termed the monitoring and knowledge component "metamemory", and he tentatively asserted that what children know about their memories probably influences how they remember.

II. **Current Conceptualizations**

1. Knowledge about Cognition versus Regulation of Cognition

Metacognition has recently been thought to include two distinct areas of research: knowledge about cognition and regulation of cognition (Brown, Bransford, Ferrara & Campione, 1983). Broadly speaking, knowledge about cognition refers to relatively stable, statable, often fallible and late developing information that human thinkers have about their own cognitive processes and those of others (Flavell & Wellman, 1977). Regulation of cognition describes a cluster of activities, or executive processes, that control and oversee cognitive processes. These activities are not stable, not statable, age-independent and task and situation dependent (Brown et al., 1983).

There is some disagreement in the literature whether executive processes should be categorized as metamemory phenomena. Some investigators have classified their work on memory-monitoring, recall readiness, and prediction of recall span as metamemory work (e.g., Lachman, Lachman & Thronesbery, 1979; Murphy, Sanders, Gabriesheski & Schmitt, 1981) whereas others have excluded executive processes from their definitions and labelled only knowledge about memory as metamemory (e.g., Cavanaugh & Perlmutter, 1982; Dixon & Hultsch, 1983b; Zelinski, Gilewski & Thompson, 1980). This dilemma points to a definitional problem, and consequently a problem in generalizing across studies.

2. Initial Conceptualizations

Flavell's Contribution. Having postulated that "knowledge about memory" plays some role in children's production deficiencies, Flavell next began to investigate the nature of that knowledge. He outlined two types: sensitivity to the need to employ memory strategies in some situations but not in others, and knowledge about strategy, task and person variables that interact to effect the quality of performance on a retrieval problem (Flavell & Wellman, 1977). Strategy knowledge involves recognizing that strategy usage in certain situations enhances memory performance; knowing that rehearsing a phone number just located helps ensure retention and that marking dates on a calendar helps to keep appointments are examples.

Task knowledge involves knowing that there are factors that make some retrieval tasks harder for most people than other tasks, or knowing, for instance, that recognition is easier than recall, that longer lists are harder to learn than shorter ones, or that interesting facts are easier to remember than banal ones.

Person knowledge is composed of several kinds of information. Firstly, it includes information about one's own characteristics, limitations and abilities as a memorizer, and it functions as an experience-linked mnemonic self-concept. An individual might feel that he/she is poor at remembering dates and places but good at remembering names, both objectively and compared to others of different ages, backgrounds, and personalities. Secondly, person knowledge also includes some understanding of the capacities, limitations and idiosyncracies of the human memory system, like that immediate memory span is small and limited duration and that retrieval is not always perfect.

Person knowledge, lastly, includes a type of mnemonic sensation or acquired ability to monitor one's own memory states. This allows an individual to assess his/her state of recall readiness, for example, or acknowledge that one datum was never stored but that another is in memory somewhere though not accessible now.

A dichotomy is suggested by this account of person metamemory. Previously acquired knowledge about the properties of self and others seems to distinguish itself from the ability to monitor and interpret concrete experiences in the here and now. Thus, the one type concerns abilities and traits, and the other refers to transient processes and states.

Strategy, task and person variables are believed to interact with one another such that a body of information, say, might be more or less retrievable depending on who is storing it and how they stored it. According to Flavell and Wellman (1977), memory performance is a function of the difficulty of the memory task and one's memory skill on that task. Task difficulty is determined by the interaction of differences in item characteristics and differences in task demands. Memory skill is determined by personal attributes and employable strategies. This model owes its conceptual roots to Heider's (1958) social cognitive model of the effects of "ability", "difficulty" and other factors on performance.

<u>Herrmann's</u> <u>Contribution.</u> Moved by recent pleas for ecological validity (e.g., Bronfenbrenner, 1977) and new interest in practical aspects of memory (e.g., Gruneberg, Morris & Sykes, 1978), Herrmann (1982, 1984) hypothesized

that besides memory knowledge, another subjective dimension probably underlies successes and failures of memory in everyday life. He thus proposed a role for memory beliefs in memory performance and advocated the use of questionnaires with items describing prototypical memory situations to assess people's beliefs about their memory.

Like Flavell, Herrmann contends that although strategies are often implicated in efficient memory performance, something must determine strategy selection and use. Memory beliefs and "memory experiences" (Herrmann, 1982, pg. 435), are thought to influence processing mechanisms, which influence performance; firsthand information from memory performance is thought to contribute to memory beliefs and experiences in a circular feedback type model (Herrmann, 1982).

While Flavell's and Herrmann's ideas bear some resemblance, nomenclature remains a problem. Herrmann does not use the word "metamemory" but rather "memory beliefs". Although not explicitly defined, memory beliefs are likely conceptually distinct from strategy or task knowledge and would likely constitute a person variable in Flavell's scheme. Herrmann's term "memory experiences" might be loosely related to Flavell's task knowledge and perhaps to person knowledge (the memory-monitoring component). Finally, Herrmann does not specify to which age group his model is directed, but presumably he is referring to adults.

3. Conceptualizations of Metamemory in Adulthood

Examples of metamemory phenomena in adults' lives are plentiful. For example, any student can report that succeeding on an examination requires more than just memorizing facts. Success requires knowing what kind of test is pending, knowing one's own prowess with such tasks, and knowing what studying techniques will maximize understanding and recall. In addition to this knowledge, though, the importance of succeeding, the individual's feeling of control over his/her success, and the anxiety inherent in entering the testing situation undoubtedly have some influence.

Recently, individuals' more general perceptions of their own cognitive ability have become important foci of researchers attempting to understand apparent age-related declines in performance in later life (Dixon & Hultsch, 1983a,b; Lachman, 1983; Zelinski, Gilewski & Thompson, 1980). Such work is partly based on the assumption that memory self-perceptions become increasingly salient in later life and contribute to observed performance decrements. This assumption derives from a life-span perspective of human development which emphasizes the importance of linkages among social, personality, and cognitive processes in development (e.g., Baltes, Dittman-Kohli & Dixon, 1984; Baltes, Reese & Lipsett, 1980; Hultsch & Pentz, 1980; Hultsch, Dixon & Hertzog, 1985).

Even a cursory analysis of the student example would suggest that there are knowledge and belief components to adult metamemory. On the basis of some recent research on personality correlates of intellectual performance in adulthood (Lachman, 1983), Dixon and Hultsch (1983b) have also hypothesized an apparent affective component in adult metamemory.

Influences of Intellectual and Personality Aging Research. There is some evidence suggesting a role for personality variables such as locus of control, anxiety, self-esteem and depression in cognitive development in old age (Lachman, 1983; Zarit, 1982). Lachman (1983) has also identified several theoretical perspectives that highlight the salience of perceptions of ability, the reciprocal relationship between perceived ability and actual performance, and the mediating role of locus of control (Bandura, 1977; Kuypers & Bengtson, 1973; Thomae, 1970).

The effects of perceived ability are manifest in at least three ways (Lachman, 1983). Firstly, perceived ability has been found to influence both the amount of effort expended on a task and also cognitions during task performance (Bandura, 1977). Intellectual performance decrements for some elderly persons could thus be a function of lowered performance expectations and concomitant increases in performance anxiety.

Secondly, in the theoretical models referred to previously, the expectancy-outcome relationship is seen as being reciprocal wherein performance outcomes provide feedback, which, in turn, influences perceived ability. In the case of intellectual aging, expectations of decline could perhaps result in subsequent performance decrements (Thomae, 1970).

Finally, it has been suggested that locus of control beliefs regulate the impact of performance outcomes on changes in expectations (Bandura, 1977; Kuypers & Bengtson, 1973). If outcomes are attributed to internal sources such as ability, then performance expectations are likely to be increased for successes and decreased for failures. If control is believed to be external, however, then expectations are less likely to be modified as a result of performance feedback (Lachman, 1983).

Lachman and Jelalian (1984) have found that subjective experiences associated with intellectual test performance do parallel objective age differences. They also found, however, that age differences on subjective dimensions such as self-efficacy and performance attribution are not global in nature but seem to vary as a function of the particular task.

Toward a Definition of Metamemory in Adulthood. Metamemory is clearly a multidimensional construct. Flavell has suggested that it includes knowledge about strategies, task demands and person characteristics. Herrmann has introduced another component, beliefs about memory. Dixon and Hultsch propose that memory knowledge and beliefs, as well as perceptions and feelings about memory might also be involved. Some extant data on older people suggest that knowledge, beliefs and affects are differentially related to actual performance (e.g., Bruce, Coyne & Botwinick, 1980; Dixon & Hultsch, 1983a; Zelinski, Gilewski & Thompson, 1980).

III. **Research Methods**

1. Methodological Problems in Metamemory Research

Measurement of knowledge and perceptions of memory has been a recurrent problem. Two of the most serious issues concern the accessibility of cognitive processes for introspective analysis and the veridicality and completeness of verbal reports (Cavanaugh & Perlmutter, 1982). In metamemory research, however, the issue is the individual's perceptions, and not the veridicality of the report. The self-reports are believed to reflect the individual's understanding or interpretation of cognitive events and are not intended to be veridical reports of cognitive processes.

Research design has also been a problem. Varying conceptual definitions have spurred development of a plethora of operational definitions, many of which lack reliability and validity (Cavanaugh & Perlmutter, 1982; Herrmann, 1982). Few studies have been replicated, and for the most part, unique interviews or questionnaires have been used in each study.

2. The Use of Questionnaires

Questionnaires are widely used in memory research both to test a certain memory ability and to elucidate metamemorial characteristics that likely relate to performance. Questionnaires are easily administered to large groups of subjects, simultaneously, with minimal instruction necessary, and easy scoring procedures.

Properties of Questionnaires. A good questionnaire should demonstrate some evidence of discriminant and convergent validity. Discriminant validity would be shown if, as a construct, metamemory were distinguishable (both empirically and conceptually) from other related constructs, such as crystallized intelligence, social intelligence, self-knowledge, achievement motivation and self-esteem (Dixon, 1985). Some tentative evidence for discriminant validity of the Metamemory in Adulthood Questionnaire (MIA) has already been gathered (Dixon, Hertzog & Hultsch, 1986).

Convergent validity reflects the extent to which the many operational definitions of the construct, which presumably represent its multiple dimensions, factors, and domains tend to converge conceptually and empirically on a consistent, coherent construct (Dixon, 1985). Again, some preliminary evidence for convergent validity of the MIA is available (Dixon, Hertzog and Hultsch, 1986).

Questionnaires will also vary in their content and format. Content refers to differences in the kinds of questions asked. The soundness of interpretation of questionnaire data depends on proper understanding of the content and on the match between content and memory issues of interest (Herrmann, 1984). Questionnaires may ask about forgetting, remembering, memory quality, memory change, memory use and feelings about memory, for example. General content areas include common events, unique events, retention of semantic information or how one performs various skills.

Given a certain content, response format may differ. For example, if frequency of forgetting is assessed, the subject may be asked how often he/she forgets in absolute terms, relative to the number of opportunities to forget or relative to how often others appear to forget. Questionnaires frequently use multiple choice questions with a Likert-type response scale.

3. The Metamemory in Adulthood (MIA) Questionnaire

The Metamemory in Adulthood Questionnaire is a 108 item multiple factor psychometric instrument developed by Dixon and Hultsch (1983b) for assessing adults. They believed that only after the structural and developmental characteristics of metamemory in adulthood are finely charted should this construct be applied to questions of age differences in performance. Work on the MIA was partially influenced by Perlmutter's (1978) Memory Questionnaire, the first designed for research on developmental differences (Herrmann, 1982). Perlmutter asked questions about older adults' memory problems, memory demands, expectations of memory change, memory strategy use and memory knowledge, but she provided no evidence of the instrument's reliability and validity. The purposes of Dixon and Hultsch's initial work, then, were, firstly, to develop an instrument to represent a multidimensional construct of metamemory in adulthood, and secondly, to examine adult age differences in the multiple dimensions of metamemory.

The first step in development of the instrument was to specify the content domain. Seven theoretically meaningful and related dimensions of the construct were identified, based on earlier metamemory work, and they divide into seven subscales as follows.

The Strategy subscale focuses on use of strategies, mnemonics and memory aids with a high score representing frequent use of memory aids. The Task subscale examines the individual's understanding of basic memory processes, especially as evidenced by knowledge of how most people would perform, and here a high score represents a high level of understanding. Perception of one's own memory capacities is assessed by the Capacity subscale where individuals reporting a higher memory capacity receive higher scores; perception of remembering abilities as subject to change over time (both one's own and others' abilities), is measured by the Change subscale. Here a high score is believed to indicate a perception of memory as generally stable. The influence of the individual's emotional state on his/her performance of memory tasks is rated by the Anxiety subscale. High scores indicate high levels of anxiety associated with performance. The perceived importance of having a good memory and performing well on memory tasks is indexed by the Achievement subscale, where the recipient of a high score seems to demonstrate high achievement motivation. Finally, the Locus subscale refers to the individual's perceived sense of control over his/her remembering skills. A high score marks an internally driven person (See Table 1).

In keeping with the recent interest in ecological representativeness, each item outlines a familiar everyday memory activity. Some of the 108 items were selected from previously developed instruments (e.g., Kreutzer, Leonard & Flavell, 1975; Lachman, Baltes, Nesselroade & Willis, 1982; Perlmutter, 1978) and some were generated by the investigators.

4. Other Questionnaires

Other than the MIA, one of the only other psychometrically sound metamemory questionnaires designed to be used with the elderly is the Memory Functioning Questionnaire (MFQ, Gilewski, Zelinski, Schaie & Thompson,

Table 1

The Seven Dimensions of the Metamemory in Adulthood (MIA) Instrument

Dimension	Description	Sample Item
1.Strategy	Knowledge of one's remembering abilities such that performance in given instances is potentially improved; reported use of mnemonic strategies, and memory aids. (+ = high use)	Do you write appointments on a calendar to help you remember them?
2.Task	Knowledge of basic memory processes especially as evidenced by how most people perform. (+ = high knowledge)	For most people, facts that are interesting are easier to remember than facts that are not.
3.Capacity	Perception of memory capacities as evidenced by predictive reports of performance on given tasks. (+ = high capacity)	I am good at remembering names.
4.Change	Perception of memory abilities as generally stable or subject to long-term decline. (+ = stability)	The older I get the harder it is to remember things clearly.
5.Anxiety	Rating of influence of anxiety and stress on performance. (+ = high anxiety)	I do not get flustered when I am put on the spot to remember new things.
6.Achievement	Perceived importance of having a good memory and performing well on memory tasks. (+ = high achievement)	It is important that I am very accurate when remembering names of people.
7.Locus	Perceived personal control over remembering abilities. (+ = internality)	It's up to me to keep my remembering abilities from deteriorating.

(Source: Dixon & Hultsch, 1983b)

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4.Change	Perception of memory abilities as generally stable or subject to long-term decline. (+ = stability)	The older I get the harder it is to remember things clearly.
5.Anxiety	Rating of influence of anxiety and stress on performance. (+ = high anxiety)	I do not get flustered when I am put on the spot to remember new things.
6.Achievement	Perceived importance of having a good memory and performing well on memory tasks. (+ = high achievement)	It is important that I am very accurate when remembering names of people.
7.Locus	Perceived personal control over remembering abilities. (+ = internality)	It's up to me to keep my remembering abilities from deteriorating.

(Source: Dixon & Hultsch, 1983b)

1983). It consists of eight subscales including a general rating of memory in terms of the kind of problems encountered, an evaluation of retrospective functioning, an assessment of one's frequency of forgetting in general, as well as separate ratings of frequency of forgetting when reading novels forgetting relative to opportunities to forget, and frequency of forgetting when reading newspapers and magazines. Other subscales include a description of the adequacy of remembering past events, a rating of the seriousness of experiencing memory failures and the frequency of using mnemonics.

Herrmann (1982) describes a series of other questionnaires that have been used to assess one or more aspects of metamemory. For example, Broadbent, Cooper, Fitzgerald and Parkes' (1982) Cognitive Failures Questionnaire asks how often in the past six months subjects experience absentmindedness, forgetting of appointments, conversations, errands and directions, and have tip-of-the-tongue experiences. Sunderland, Harris and Baddeley's (1984) Everyday Memory Questionnaire covers similar content, only this instrument was designed to measure head injury patients. The Inventory of Memory Experience (Herrmann & Neisser, 1978) assesses frequency of remembering from childhood, remote memory and recent memory. The content of Sehulster's (1981) Memory Scale resembles Perlmutter's (1978) scale, but as well, it includes estimates amounts of memory knowledge of music and trivia.

IV. Empirical Studies of Metamemory in Adulthood

1. Age Differences

At present, questionnaire research has yielded inconsistent data on age differences, little conclusive data demonstrating strong metamemory/memory performance relationships, and no data on the lability issue. As Dixon and Hultsch (1983b) observed, despite the paucity of work done, contrasting results have already emerged. For example, some studies have found that younger adults performed better than older ones when metamemory was operationalized as ability to assess memory task demands, prediction of recall prior to exposure to the memory task, recall readiness and spontaneous use of effective acquisition tactics (Bruce, Coyne & Botwinick, 1982; Murphy, Sanders, Gabriesheski & Schmitt, 1981; Perlmutter, 1978). Conversely, no age differences have been revealed for operational definitions of metamemory such as recall prediction accuracy after the learning task, some memory monitoring (prediction and confidence ratings), accuracy of information about memory contents and general knowledge about the facilitative effects of memory strategies (Bruce et al., 1982; Lachman et al., 1979; Murphy et al., 1981; Perlmutter, 1978).

Early Work. Memory monitoring apparently has been the object of study more often than has memory knowledge (Bruce et al., 1982). One of the few studies that has addressed age differences in memory monitoring and in memory knowledge simultaneously was conducted by Perlmutter (1978). She sampled 64 males and females who were either in their 20s or in their 60s and who had either a high school education or a doctoral level education.

Memory knowledge was measured using the 60 item Memory Questionnaire which assessed memory problems faced in day-to-day life, subjects'expectations of memory change with age, things subjects found easy and difficult to remember and mnemonic strategy use. Memory monitoring skills were evaluated by measuring subjects' ability to predict their memory performance and by asking them to rate their degree of confidence in the accuracy of their memory. They also were asked to comment on the number of memory problems they felt they experience, the number of memory demands they generally encounter, and the amount of anxiety they had felt in the testing situation.

Although Perlmutter's older subjects reported experiencing more memory problems than her younger subjects, no age differences were found in the memory demands generally encountered, in use of memory strategies, and in knowledge about memory. While 15% of subjects experienced anxiety, an increased level of anxiety was not associated with any particular age group. Similarly, on the memory monitoring tasks, she found no age differences in prediction of recall span or in confidence ratings for both word memory and fact memory.

The old and the young, then, both seem to recognize the facilitative effects of memory strategies and seem to have comparable knowledge of memory. These findings contrast with work done with young children. Developmental differences in performance appear to be partially attributable to young children's limited knowledge about memory and disinclination to deliberately carry out strategies. The elderly, rather, appeared to be knowledgeable about memory and inclined to engage in activities to facilitate performance (Perlmutter, 1978).

Significant correlations between prediction accuracy and performance and between confidence rating and performance were also obtained. This supports a view that memory monitoring may be related to proficient memory performance. However, since the two age groups showed comparable accuracy in memory monitoring, differences in memory monitoring skills do not seem to contribute to age differences in adult memory. Older people seem quite capable of assesing when to use memory strategies (Perlmutter, 1978). Lachman et al. (1979) found consistent results using feeling-of-knowing judgments for real-world factual information, but Murphy et al. (1981) found contradictory results in a study of recall span prediction using line drawings. Again these data contrast with data from children. Young children are not as competent as older ones at monitoring their memories (Flavell & Wellman, 1977).

As Perlmutter notes, although younger and older adults appeared to know about as much about memory, were equally inclined to attempt to use memory strategies, and were similarly competent in monitoring memory, there was some evidence that the older subjects did not spontaneously use as effective strategies as the young. However, the old were capable of engaging in effective acquisitional processing when given appropriate instruction. Perlmutter concluded that part of observed age differences might be attributable to production deficiencies. This is similar to work with children. Both young children and older adults, then, might be capable of more effective mnemonic processing than they spontaneously exhibit (Perlmutter, 1978).

Work With the MIA. Motivated partially by Perlmutter's (1978) pioneering work on memory knowledge in adulthood and partially by the inadequacy of procedures which measure metamemory unidimensionally, Dixon and Hultsch (1983b) measured age differences on seven conceptually distinct metamemory dimensions using the MIA. In order to be able to cross-validate their results, Dixon and Hultsch tested three samples of community dwelling adults from a small city in Pennsylvania. Sample 1 was composed of 60 young (aged 18-37) and 60 old (aged 50-81) male and female adults. Sample 2 was composed of 36 young (age 21-39), 36 middle-age (39-58) and 36 old (60-84) female adults. In sample 3 were 50 young (aged 21-39), 50 middle-aged (aged 38-58) and 50 old (aged 60-74) female adults. The overall sample, then, included 146 young, 86 middle-aged and 146 older adults.

Four specific outcomes were hypothesized: (a) no age difference on Strategy; (b) younger adults will score higher than older adults on Task; (c) younger adults will score higher than older adults on Capacity; and (d) younger adults will view memory as more stable and thus score higher on Change than older adults. Younger subjects were also expected to have higher total scores than older ones.

A one factor (Age) MANOVA on the first sample yielded a discrimination of age groups on Task, Capacity, Change and Locus. Follow-up Bonferroni t comparisons indicated that the young group scored significantly higher than the old group on Task, Capacity and Change.

Age differences were also found in Sample 2. Age discrimination was found on Capacity, Change and Locus. Follow-up Bonferroni t contrasts found the young scoring significantly higher than the old on all three subscales, but significantly higher than the middle-aged on only the Change subscale. Middle-aged subjects scored significantly higher than the old only on the Change subscale.

Sample 3 yielded similar results. Age differences, were again found on Task, Capacity and Locus.

No differences on Strategy were found in any of the samples. Finally, three ANOVAs were conducted on the total metamemory score. In Sample 1, the young scored significantly higher than the old. In Sample 2, the young scored significantly higher than both the middle-aged and the old, who did not differ significantly. In Sample 3, the young scored significantly higher than the middle-aged who scored significantly higher than the old.

The results of three samples, then, supported the authors' a priori hypotheses. In addition, in all three samples, the young were found to be more internal than the old as indicated by higher scores on the Locus subscale.

Dixon and Hultsch concluded that younger adults have superior knowledge of memory. The old seem to show a lack of understanding of task characteristics, seem to have an awareness that some decline in memory ability may occur with age, and seem to adhere to a belief in the certainty of this decline.

Despite these preliminary results, the robustness of age-related differences in metamemory dimensions remains somewhat unclear and the literature remains somewhat inconsistent (Hultsch, Hertzog & Dixon, in press). For example, although several studies report no age differences in use of strategies (e.g., Dixon & Hultsch, 1983b; Gilewski et al., 1983; Perlmutter, 1978), Weinstein, Duffy, Underwood, MacDonald and Gott (1981) report that older adults use fewer strategies than younger adults. Where in some studies older adults report more memory failures in everyday activities than younger ones (e.g., Gilewski et al., 1983; Perlmutter, 1978), other studies suggest that younger adults report more of such problems (e.g., Sunderland, Harris & Baddeley, 1984). Indicators of perceived memory abilities or capacities are equally contradictory. Dixon and Hultsch (1983b), Gilewski et al. (1983) and Zelinski et al. (1980) found that older adults had a poorer perception of their memory for various content domains than younger adults. Chaffin and Herrmann (1983) found positive, equivalent and negative age differences across domains while Bennett-Levy and Powell (1980) found positive age effects. The most consistent finding is a perception amongst older adults that their memory has declined (Dixon & Hultsch, 1983b; Gilewski et al., 1983; Perlmutter, 1978; Williams, Denney & Schadler, 1983).

Hultsch, Hertzog and Dixon (in press) have attempted to resolve some of the inconsistencies surrounding the robustness of age related differences in metamemory. They conducted a large scale validation study using the MIA and the MFQ (Gilewski et al., 1983) on two samples of approximately 400 subjects each, drawn from two separate cities. The sample selected from one city, Victoria, and which included young students and middle age and older community-dwelling adults, was comparable to the samples traditionally used in cross-sectional aging research. The second sample taken from Annville, Pennsylvania, represented an age range of 20-78, but included at least thirty individuals from each decade none of whom was enrolled in school. Before being given a battery of other tests, these subjects were given the two metamemory measures.

Multivariate analyses yielded age and sex differences on both the MIA and MFQ. Univariate analyses found age differences on Capacity and Change with Change accounting for 27% of the variance in the Victoria sample and 13% in the Annville sample. These findings are consistent with Dixon and Hultsch (1983b). Differences found on the Locus subscale suggest that older people believe that there is little they can do to enhance their memory or prevent its deterioration, a result which is also consistent with Dixon and Hultsch (1983b). Locus accounted for 5% of the variance in the Victoria sample. Finally, age differences were seen on two highly correlated measures, the MIA Strategy subscale in the Victoria sample and the mnemonics subscale in Annville. In this study, the older groups showed more use of strategies than the younger. This finding is not consistent with Dixon and Hultsch (1983b).

Sex differences were found, but they accounted for very small parcels of variance. Women evidenced more strategy use and greater anxiety. No age by sex interactions were found on the MIA.

The most pronounced age differences appeared when young university students were contrasted with late middle-aged and older community residents. Age-related differences within the middle-age and elderly groups seemed fairly fragile. In addition, in this study, the metamemory test preceded other memory tests. In at least one other study the MIA was given after a battery of tests.

2. <u>Metamemory/Memory Performance Relationships</u>

Studies investigating the metamemory/memory performance relationship have also been inconsistent. It seems that the operational definition of metamemory and the particular memory tasks used play a role in the results (Dixon & Hultsch, 1983a). For example, when metamemory was operationalized as the ability to assess memory task demands or as prediction of recall span, older adults performed significantly poorer than younger adults. When recall prediction accuracy was used instead, no age differences were found (Bruce et al., 1982; Perlmutter, 1982). Other conflicting results can be found in Murphy et al. (1981) and Lachman et al. (1979).

<u>Work with the MIA</u>. Dixon and Hultsch (1983a) examined the relationship between seven MIA dimensions and memory for

text. Three samples were used to allow cross-validation of results.

Sample 1 consisted of 30 young (aged 18-32) and 30 old (aged 60-81) subjects. Sample 2 was composed of 36 young (aged 21-39), 36 middle-aged (aged 39-58) and 50 old (aged 60-84) adults. Sample 3 was composed of 50 young (aged 21-39), 50 middle-aged (aged 39-58) and 50 old (aged 60-74) participants. These samples were similar to samples used by Dixon and Hultsch (1983b).

Results suggest that metamemory/memory linkages differ in composition for each age group. For the young group, Strategy, Capacity and Task best predicted text recall, whereas for the middle-aged, Strategy, Task, Capacity and Achievement were the best predictors. For the oldest group, predictors included Task, Achievement and Locus. Task, then, appeared to be an important predictor across adulthood and memory-related affect seemed to be a salient predictor in old age. That is, whereas memory performance of young adults is best accounted for by knowledge components of memory, in this study, older adults' performance seems more related to the affective dimensions such as beliefs and feelings about memory. Older adults' memory performance, then, may be more susceptible than that of younger adults to noncognitive influences (Dixon & Hultsch, 1983a).

The salience of the affective predictors in old age was not replicated in another study by Dixon, Hertzog and Hultsch (1986) which considered the relationship between the MIA and performance on a series of standard psychometric cognitive and memory tasks. Measures included two indicators each of verbal comprehension, induction, digit span, associative memory (object number test, and memory for words), associational fluency and ideational fluency. Fifty young, 50 middle-aged and 50 older women were tested. Previous research using items or variables analogous to some MIA dimensions and similar memory tasks found that word memory was associated with memory knowledge (Perlmutter, 1978) and with several categories of the MFQ (Zelinski et al., 1980). Digit span has also been found to correlate with aspects of subjective experience (Bennett-Levy & Powell, 1980).

Hypothesized relationships between Task and verbal comprehension measures were found for all age groups, and a hypothesized absence of correlation between Task and induction measures was also noted. Observed correlations between Task and word memory provided a partial replication of Perlmutter's (1978) results. Hypothesized associations between Strategy and memory performance measures (forward and backward span and associative memory) were observed in eight out of twelve possible cases. There was also some evidence for a greater relation between Strategy and verbal comprehension in the old than in the young, and evidence for a greater relationship between Strategy and induction in the young. Interestingly, a hypothesis of a negative correlation between Anxiety and performance, especially in the elderly, was not supported. In the earlier text recall study, Anxiety was also not related to performance but Achievement and Locus were. In this study, Task and Strategy seemed to be more salient predictors than were Capacity and Change.

To date research on the metamemory/memory performance relationship elucidates three general conclusions: (a) obtained patterns of age-related differences in metamemory per se are, in part, a function of the aspect under investigation; (b) obtained patterns of metamemory/memory correlations are, in part, a function of which indicators are selected from each domain, and (c) there may be age-related differences in the pattern of these correlations in adulthood (Bennett-Levy & Powell, 1980; Chaffin & Herrmann, 1983; Dixon & Hultsch, 1983a; Dixon, Hertzog & Hultsch, 1986; Sunderland, Harris & Baddeley, 1983).

Methodological Issues. In these studies, significant correlations have often been weak to moderate. Weak correlations, however, have been informative in at least four ways (Herrmann, 1982). Firstly, if both metamemory and memory are not unitary phenomena, then there is no theoretical reason to expect necessarily high correlations among any or all of the multiple dimensions. Failure to consider precisely which dimensions of metamemory might be related to which dimensions of memory, and failure to measure these dimensions accurately could yield small validity coefficients.

Likewise, there may be ecological specificity in metamemory/memory relations. If metamemory subscale scores change as a function of changing memory-demanding situations, memory knowledge and beliefs may be only conditionally related to memory performance.

Furthermore, it is not yet clear whether metamemory is more state-like or trait-like. If, across occasions, memory knowledge, perceptions and beliefs are found to be labile, then perhaps previously observed relationships in one-time-of-measurement cross-sectional studies might be spurious altogether.

Finally self-knowledge of memory may be integrated into a larger system of self-knowledge, self-beliefs and self-perceptions (Sehulster, 1981). Hypothesized metamemory/memory correlations may be weakened by unidentified broader factors.

Conclusions. Overall, then, there seems to be domain specificity in metamemory/memory relationships across adulthood as evidenced by differential prediction of memory task performance by metamemory dimensions. There also might be a change in the salience of metamemory dimensions with increasing age.

These conclusions challenge several fundamental assumptions underlying cognitive aging work (Dixon, 1985). The present position asserts that ontogenetic change in underlying mental processes constitutes only one contributing factor to age-related changes in complex cognitive behaviors. This contrasts with the traditional position which claims that memory performance measures indicate stable processing traits which show age-related decline. This position also contrasts with the view that measurement is unaffected by labile performance characteristics such as the familiarity of the task, self-efficacy beliefs, or the lability of physiological and psychological states which are different than age changes. Evidence that these types of factors are operating would provide an alternative explanation for empirically observed interindividual differences in memory functioning.

CHAPTER 3

METHODS

I. Subjects

The data were collected in the summer of 1985 as a one year follow up of Read's (1985) study. Participants included 185 male and 191 female volunteers, all community-dwelling Victoria residents who ranged in age from 54-93. The 376 subjects were classified into four age/sex groups. There were 52 females and 52 males in the age 54-61 group (M=57.68 years, SD=2.18), 53 females and 54 males in the age 62-68 group (M=65.07 years, SD=2.06), 52 females and 45 males in the age 69-75 group (M=71.69 years, SD=2.17) and 33 females and 34 males in the age 76-93 group (M=80.13 years, SD=3.98). Generally speaking, individuals aged 54-61 have not retired while many people aged 61-69 have. Individuals aged 69-75 are considered the young-old while individuals aged 76 and over have been called the old-old.

The mean number of years of education in the total sample was 13.64. As a group, 69-75 year old males were the most educated (M=14.64 years, SD=3.21) and 76-93 year old males were the least educated (M=12.91 years, SD=4.09). Mean years of education for all groups can be found in Table 2.

Subjects were recruited through newspaper, television, radio, poster and individual appeals, and all were prescreened on the phone for prior history of organic brain disease (e.g., epilepsy, brain tumor, stroke, Parkinson's Disease) and visual disabilities. Individuals reporting any of these problems were not included in the study. Acceptable candidates were scheduled for an appointment and reminded by telephone the day before. In general, then, the present sample is comparable in age and education to earlier samples used in adult metamemory research.

II. Design

Each age/sex group was randomly divided into two groups, one which received the MIA prior to the memory tests and one which received it following the memory tests. In the 54-61 age group, 26 females and 29 males received the MIA before and 26 females and 23 males received it after. In the 62-68 group, 27 females and 26 males received the MIA

Table 2

Mean Levels of Education by Age/Sex Group

Age	Sex	n	Mean Years	SD
54-61	Female	52	13.60	3.24
	Male	52	13.98	3.50
62-68	Female	52	13.44	2.46
	Male	54	13.89	3.49
69-75	Female	51	13.14	3.20
	Male	45	14.64	3.21
76-93	Female	33	13.24	3.35
	Male	34	12.91	4.09

before and 26 females and 28 males received it after. In the 69-75 group, 26 females and 21 males received the MIA before and 26 females and 24 males received it after. Finally, in the 76-93 group, 18 females and 20 males received the MIA before and 15 females and 14 males received it after.

III. Measures and Procedures

Participants completed a battery of questionnaires and tasks including indicators of metamemory, memory performance, subjective health, mental status and mood (Read, 1985). All measures were administered individually by a female experimenter. The present report concerns the metamemory data and a subset of memory performance variables including those showing the greatest amount of variability. The following measures were examined.

1. Metamemory Measure

The 108 item Metamemory In Adulthood questionnaire was designed explicitly for use with older people. The broad conceptual space it covers was defined after reviewing the lifespan literature on the influences of metamemory, metacognition, self-efficacy beliefs and personality states and traits on cognitive performance. From this review, eight theoretically meaningful dimensions were extracted, seven of which are represented in the version in the MIA used here. Items were specifically designed to reflect everyday memory activities and behaviors and used a five point Likert scale (Dixon & Hultsch, 1983b).

The instrument was designed specifically to be factorially heterogeneous but to exhibit homogeneity within each of the subscales. Six subscales (Strategy, Task, Change, Anxiety, Achievement and Locus) appear to be reliable and factorially valid. Internal consistencies (Cronbach's alpha) for the seven subscales ranged from .61 to .91 (M=.81) over multiple samples. Factor loadings ranged from .31 to .83 (Dixon and Hultsch, 1983b). The Capacity subscale was internally consistent but appears strongly correlated with the Change subscale (Dixon & Hultsch, 1983b).

2. Memory Measures

Rationale for Use. The battery of memory tests consists of verbal and performance tests either designed or adapted for use with the elderly by Dr. Donald Read at the University of Victoria. There are several advantages to Read's battery for assessing older persons' memory performance. Firstly, it is based on a neuropsychological approach which aims to thoroughly and comprehensively evaluate major aspects of memory. It includes measures of primary, secondary and tertiary memory, and it employs both immediate and delayed recall tests and recognition tests. Read's stimulus materials are both verbal and visual, and some stimuli are familiar and some are unfamiliar. Visual memory tests have not been used before in research on metamemory/memory relationships in adulthood.

Secondly, the battery is designed to assess older adults' memory competence and minimize performance factors. The older subject's best possible level of performance is sought by providing optimal encoding opportunities and retrieval cues. No time limits are set for any task. Given the individual administration, the test administrator can also monitor each subject's level of fatigue, boredom or anxiety and offer breaks and support where necessary.

Order of Test Administration. There were 25 measures in the complete battery; a subset of nine have been selected for analysis. Those nine tests were administered in the following order: (1) Auditory-Verbal Learning Test (AVLT): Immediate Recall; (2) AVLT: Delayed Recall; (3) Supermarket

Test: Immediate Recall of Item Names; (4) Supermarket Test: Immediate Recall of Item Location; (5) Digit Span Forward; (6) Digit Span Backwards; (7) Sequential Geometric Design Test: Delayed Recall of Drawing Parts; (8) Supermarket Test: Delayed Recall of Item Names; and (9) Visual Closure Test: Delayed Recall of Drawing Names.

Auditory-Verbal Learning Test (AVLT, Rey, 1964). The AVLT resembles traditional word list learning tasks. On the first trial, a list of 15 common words in alphabetical order is read, one per second. The subject is instructed to recite back as many as he/she can remember in any order. The number correct is recorded. The first trial, then, measures immediate memory span using immediate free recall. On the next four trials, the examiner reads the same list, and the subject is repeatedly asked to recite all words remembered, including those recited originally. Trials 2-5 are intended to facilitate verbal learning. After a 5 minute distractor task, a test of delayed recall is given. If all 15 words are not recalled, a recognition test is given. Only scores from Trial 1 (Immediate Free Recall) and the delayed recall test are included in the present analyses.

The Visual Closure Test. This test is adapted from Gollin

(1960). The subject is shown a fragmented line drawing of a common object and asked to guess the identity of it within thirty seconds. If he/she fails, the unidentified item is shown again with more of the outline added to facilitate identification. Four levels of completeness are possible with the fourth being the completed drawing. Two incomplete drawings are presented initially for practice. In Part 1, subjects are shown twelve test items, one at a time, in the same way. Each failure to identify an item at a given level is counted as an error. Part 2 begins ten minutes later. The subject is asked to identify the same twelve drawings again, and again failure to identify an item at a given level is counted as one error. A Percentage Savings Score is computed using the individual's scores on Part 1 and Part 2 and a formula which Read (1985) outlines. Once all the items have been identified correctly in Part 2, the subject is shown each of the completed drawings again and asked to name them. This step is included to facilitate encoding. Approximately 25 minutes later, a delayed recall test of the names of the drawings is given, and credit is given for each item recalled. If the total is less than 12, a two item forced-choice recognition test is given. Only the score of the delayed recall of drawing names is included in the present analyses.

Supermarket Test. The idea for this unusual test came from the work of Mandler, Seegmiller and Day (1977), which was adapted for experimental clinical use by Smith and Milner (1981). Initially, the subject is asked to name and estimate the price of 16 common supermarket items (e.g., a can of Campbell's soup, a package of Jello, a box of raisins) that are located on three shelves of a miniature supermarket. This step is designed to facilitate optimal encoding. Next, the supermarket doors are closed and an immediate oral free recall test of the names of the 16 items is given. Credit is given for each item recalled. The experimenter then removes the items from the back of the supermarket and hands them to the subject on a tray. The individual must replace them to their correct location in the supermarket. This is a test of immediate recall of item location, and credit is given for each item that is replaced on its original shelf, regardless of where it is placed on the shelf. After 30 minutes, the subject is asked to recall the item names. If all items are not recalled, a two-item forced choice recognition test is then given. Only scores from the Immediate Free Recall of Item Names, the Immediate Recall of Item Location and the Delayed Free Recall of Item Names tests are included in the present analyses.

Digit Span Tests. The Forward and Backward Digit Span tests are adapted from the Wechsler Adult Intelligence Scale - Revised (Wechsler, 1981). These are tests of immediate rote memory and concentration. A series of numbers is read to the subject and he/she must repeat the series back in the same order, on the forward span tests, and in reverse order on the backward span tests. The first series has three numbers, and after a first trial, a different series of three numbers is presented. If either of those two strings is repeated correctly, two different four-digit strings are presented, one at a time. If at least one trial is correct, two five digit strings are presented, and so on. The test continues until the subject is unable to repeat a given series correctly on either trial. All forward trials are given first and then all backward trials. Two points are awarded if the first of the two trials is correct and only one point if a second correct trial follows an initial incorrect one.

Sequential Geometric Design Test. This test, adapted from the Rey-Osterrieth Complex Figure Test (Osterrieth, 1944; Rey, 1942, 1964), is a good measure of visuoperceptual ability and nonverbal memory in young adults (Lezak, 1983).

Read's version of the task for older adults is adapted from L'Hermitte, Derouesne and Signoret (1972). Firstly, the subject is asked to copy one scorable item from Rey's original figure at a time until the figure is completed. The individual is given a rectangle to start with and then adds specific lines and shapes to it. Copying is designed to make encoding simpler and more systematic, and it takes about three minutes. Five to eight minutes later, the subject is asked to draw as much of the 18 part figure as he/she can remember and is cued with the original drawing of the rectangle if he/she recalls nothing. Both the copy and the recall drawing are scored according to Osterrieth's (1944) criteria. Only the score of the Delayed Recall of the Drawing Parts is included in the present analyses.

<u>Summary.</u> Fifteen memory measures were described. The major groupings include the AVLT, the Visual Closure, Supermarket, Digit Span, and Sequential Geometric Design tests. Nine memory measures will be included in the analyses. (See Table 3.) They are: (1) AVLT: Immediate Free Recall, (2) AVLT: Delayed Recall, (3) Visual Closure: Delayed Recall of Drawing Names, (4) Digit Span Forward, (5) Digit Span Backward, (6) Supermarket: Immediate Recall of

Table 3

The Nine Memory Tests Used in Analyses

I.	Auditory-Verbal Learning Test	1. Immediate Recall 2. Delayed Recall
II.	Visual Closure Test	3. Delayed Recall
III.	Sequential Geometric Design Test	4. Delayed Recall
IV.	Supermarket Test	5. Immediate Recall of Item Names 6. Immediate Recall of Item Location 7. Delayed Recall of Item Names
V.	Digit Span	8. Forward 9. Backward

Item Names, (7) Supermarket: Immediate Recall of Item Location, (8) Supermarket: Delayed Recall of Item Names, and (9) Sequential Geometric Design: Delayed Recall of Drawing Parts. The Delayed Recognition parts of the AVLT, Visual Closure and Supermarket tests and the Percentage Savings Score of the Visual Closure test are not included in the analyses because they show little variability.

These tasks, some traditional, some unique, were modified for use with the elderly. No stringent time limits were enforced; opportunities for encoding were maximized and retrieval cues were utilized. Where possible, the stimuli were presented systematically, and in the Visual Closure and the Supermarket tests the stimulus materials were familiar objects. The battery was specifically designed to optimize performance and assess memory competence. Attempts were made to minimize performance factors such as fatigue, anxiety and lack of familiarity.

IV. Analyses

Age, Sex and Order effects on metamemory were analyzed using a 4(Age) by 2(Sex) by 2(Order) Multivariate Analysis of Variance with seven dependent variables (the MIA subscale scores). The relationship between metamemory subscale scores and the various memory performance measures were examined by Canonical Correlational analysis of the seven MIA subscales and the nine memory measures. An analysis of age differences in correlation patterns was also included.

Rationale for Using Canonical Correlation. Canonical Correlation is the multivariate generalization of Simple Correlation and Multiple Regression. It is a technique for analyzing the relationship between two sets of variables. Each set can contain several variables. Simple Correlation and Multiple Regression are special cases of Canonical Correlation wherein one or both sets contains a single variable.

Given two sets of variables, Canonical Correlation finds a linear combination from each set, called a canonical variate, such that the correlation between the two canonical variates is maximized. This correlation between the two canonical variates is called the first canonical correlation. It is tested for significance using Wilks' Lambda or Roy's Greatest Characteristic Root Test. The first canonical correlation is at least as large as the multiple correlation between any variable and the opposite set of variables. It is possible for the canonical correlation to be very high even if all the multiple correlations are low.

Canonical Correlation continues by finding a second set of canonical variates, uncorrelated (or orthogonal) to the first pair, that produces the second highest correlation coefficient. The process of constructing canonical variates continues until the number of pairs of canonical variates equals the number of variables in the smaller group (Harris, 1975; SAS User's Guide, 1985).

To say that the first canonical correlation is significant is to say that the two variates are related along one underlying dimension. A dimension is like a factor, or a "line" in a multivariate space that can be looked along in order to calculate a correlation. The "line" is optimized to maximize the correlation and minimize the sums of squares error. Canonical correlation, then, conducts a simultaneous factoring of both data sets such that the correlation between them will be maximized and the error minimized.

V. Hypotheses

1. Age, Sex and Order Effects In Metamemory

On the multivariate test, significant main effects for age and sex are expected at the .05 level. MIA presentation order and all the interaction terms are not expected to be significant.

On the univariate tests, significant age differences are expected on the Capacity and Change subscales. Decrements are expected across the four age ranges. Such results would replicate Hultsch, Hertzog and Dixon (in press) within a smaller age range. It should be remembered that the Capacity subscale indexes the memory capacity that individuals think they have and not the capacity they actually have, and that Capacity and Change seem to operate on the same parcel of variance.

Since students are excluded, Capacity and Change may account for less variance than they did in Hultsch et al.'s (in press) study wherein Capacity accounted for 11% and Change accounted for 27% in the Victoria sample. Large variance overlaps might have resulted from large age differences between groups.

Significant age differences are also expected on the Locus subscale but not on the Anxiety or Achievement subscales. The oldest group will likely believe that there is little they can do to enhance their apparently failing memories or prevent their deterioration. Such a result would be consistent with Hultsch et al. (in press). Age, however, will probably account for less than 5% of the variance.

No age differences are expected on the Strategy and Task subscales, and this, again, would support Hultsch et al.'s (in press) results. These predictions are tentative, however, since age differences seen in earlier work seem to be fragile (Hultsch, Hertzog & Dixon, in press).

Sex differences are expected on Strategy and Anxiety. Women are likely to report more strategy use and more anxiety associated with memory-demanding situations. The amount of variance accounted for will probably be low. Finally, no difference is expected between groups of either sex and any age receiving the MIA before the memory tests and those receiving it after.

2. Metamemory/Memory Relationships

The multivariate test is expected to yield one significant canonical correlation. Correlation patterns are hypothesized to be domain specific, to shift with age and to fall between .2-.5. Also, like Dixon, Hertzog and Hultsch (1986) and unlike Dixon and Hultsch (1983a), the Task and Strategy subscales will be related to memory performance in more instances than any others.

Specifically, it is hypothesized that Strategy and Task will each be positively correlated with the Immediate Recall, Recall of Item Location, and Delayed Recall parts of the Supermarket Test. This prediction is based on Berry, West and Scogin's (1983) findings of higher performance on "everyday" memory tasks than on laboratory memory tasks (presumably because of greater task knowledge and stimulus familiarity). For this reason, Strategy and Task will probably not correlate with the Sequential Geometric Design Test. Strategy and Task also will each probably correlate with Backward Digit Span, as Dixon, Hertzog and Hultsch (1986) found, and with both measures of the AVLT. These latter results would be consistent with Dixon et al.'s (1986) findings on word memory. No age differences in correlation patterns for correlations involving Strategy and Task are expected. Such a finding would also be consistent with Dixon et al. (1986).

It is further predicted that Anxiety, Achievement and Locus will not correlate with any performance measure. Such results would support Dixon et al.'s (1986) findings. Previous research has suggested that older people believe that they have little control over their perceived inevitable memory deterioration. An absence of correlation between Locus and performance would suggest that such beliefs do not influence performance. Finally, if changes in beliefs of memory self-efficacy do play some role in performance decrements frequently seen in the elderly, then some correlations between both Capacity and Change and some of the memory performance measures should be seen.

CHAPTER 4

RESULTS

I. Age, Sex and Order Effects in Metamemory

The means and standard deviations of the seven MIA subscales by age and sex and listed in Table 4. A 4(Age) by 2(Sex) by 2(Order) MANOVA was conducted on the seven subscales of the MIA. Three hundred and seventy-five subjects were included. The data for one subject was excluded because her age was missing. As hypothesized, there were significant main effects for Age (F = 2.722, p<.000), and for Sex (F = 4.15, p<.000). MIA presentation order and the interactions were not significant.

Univariate tests found significant age differences on two subcales: Change (F[3,359] = 4.53, p<.004), and Achievement (F[3,359] = 7.34, p<.000). Change accounted for 3% of the variance and Achievement accounted for 6%. Follow-up analyses using Bonferroni ts at the .05 level indicated that on Change, the 54-61 and 62-68 year olds scored significantly higher than the 76-93 year olds. No other age comparisons were significant. A high score on Change is believed to indicate a perception of memory as generally stable.

Table 4

Mean MIA Subscale Scores as a Function of Age and Sex

MIA	SD	Age							
		54-61		62-68		69-75		76-93	
		F	M	F	M	F	M	F	M
Str	9.67	65.48	62.76	64.65	62.78	66.05	61.19	66.55	65.96
Task	5.96	62.69	64.40	63.14	64.62	63.71	63.46	62.46	64.00
Cap	9.11	55.64	51.56	52.40	49.70	53.03	49.83	54.61	50.19
Chan	11.38	55.05	51.17	53.05	50.85	53.60	49.40	48.33	45.39
Anx	8.64	38.27	39.04	38.76	39.19	39.71	39.75	39.52	41.26
Ach	7.50	55.67	54.83	57.60	55.45	57.71	56.52	61.07	60.03
Loc	5.20	30.95	31.19	31.13	31.05	30.92	29.73	29.67	28.97

Table 4

Mean MIA Subscale Scores as a Function of Age and Sex

MIA	SD	Age							
		54-61		62-68		69-75		76-93	
		F	M	F	M	F	M	F	M
Str	9.67	65.48	62.76	64.65	62.78	66.05	61.19	66.55	65.96
Task	5.96	62.69	64.40	63.14	64.62	63.71	63.46	62.46	64.00
Cap	9.11	55.64	51.56	52.40	49.70	53.03	49.83	54.61	50.19
Chan	11.38	55.05	51.17	53.05	50.85	53.60	49.40	48.33	45.39
Anx	8.64	38.27	39.04	38.76	39.19	39.71	39.75	39.52	41.26
Ach	7.50	55.67	54.83	57.60	55.45	57.71	56.52	61.07	60.03
Loc	5.20	30.95	31.19	31.13	31.05	30.92	29.73	29.67	28.97

On Achievement, Bonferroni *t*s suggested that the 54-61, 62-68 and 69-75 year olds, respectively, scored significantly lower than the 76-93 year olds. A high score on Achievement is believed to index high achievement motivation. No other comparisons were significant.

Univariate follow-up tests on the significant multivariate Sex effect yielded differences on three subscales: Strategy ($F[1,359] = 6.12$, $p<.014$), Capacity ($F[1,359] = 14.42$, $p<.000$) and Change ($F[1,359] = 7.89$, $p<.005$). On all three, females scored higher than males. Sex accounted for 2% of the variance on Strategy, 4% on Capacity and 2% on Change. A high score on Strategy represents frequent use of memory aids. On Capacity, individuals reporting a higher memory capacity receive a higher score.

II. Metamemory/Memory Relationships

There were 364 subjects included in the analyses. The same subject whose age was missing also failed to complete all the memory tests. The data for eleven subjects were excluded because either they had severe hearing problems or previously undetected severe visual or memory problems.

The intercorrelation matrix used in the following analyses is presented in Table 5. Anxiety and Change evinced a pattern of significant simple correlations with the memory measures. Capacity was also occasionally correlated significantly. Achievement and Locus did not correlate with performance except in two isolated instances. Unlike earlier results with primary mental abilities, wherein Strategy and Task showed frequent correlations with ability measures (Dixon, Hertzog & Hultsch, 1986), only three of the correlations involving Task and none of the correlations involving Strategy were significantly related to the memory measures. Thus, the notion of domain specificity in relationships between aspects of metamemory and performance measures was given some support. To get a better impression of the relationship between the MIA and the memory variables, a canonical analysis was performed.

Canonical Correlation analysis on the intercorrelation matrix was conducted with the seven MIA subscale scores and the nine memory variables. Overall, there was one significant canonical correlation (R = .39, adjusted R = .36, F = 7.244, p<.0001). The metamemory canonical variate and the memory canonical variate, then, seem to be related on one underlying dimension. The standardized canonical coefficients for the MIA subscale scores and the memory

Table 5

Correlations Between Memory Measures and Subscales of the MIA

T	Age Grp	Str	Task	Cap	Chan	Anx	Ach	Loc
1.	1	.06	.18	.27b	.27b	-.09	.01	.05
	2	.09	.02	.06	.13	-.23a	-.03	.04
	3	-.11	.09	.10	.13	-.21a	-.06	.13
	4	.14	-.17	.14	.27a	-.21	-.05	-.02
2.	1	.06	.23a	.16	.18	-.10	.14	.13
	2	-.05	-.05	.01	.14	-.07	-.02	.06
	3	.01	.14	.03	.19	-.22a	-.07	.06
	4	-.09	-.13	.12	.15	-.12	.09	-.04
3.	1	.13	.11	.28b	.17	-.27b	.00	.06
	2	-.02	-.07	.09	.22a	-.29b	-.11	.09
	3	-.02	-.05	.05	.14	-.19	-.05	-.01
	4	-.02	.06	.08	.06	-.17	-.05	.00
4.	1	.11	.17	-.10	.01	.04	.22a	.16
	2	.09	-.09	.01	.14	-.15	-.03	-.05
	3	.07	.06	.14	.16	-.30b	-.16	-.07
	4	.01	-.05	.08	.19	-.12	.12	.20
5.	1	.12	.20a	.14	.11	-.12	.14	.13
	2	.10	.01	.22a	.14	-.13	.09	.10
	3	-.02	.06	.16	.27b	-.33b	.01	.21a
	4	.05	-.05	.05	.03	-.17	.05	-.12
6.	1	.27	.13	.15	.08	-.10	.15	.03
	2	.09	.07	-.09	-.17	-.01	.10	.05
	3	.18	-.09	-.10	-.17	-.16	-.01	.15
	4	.09	-.21	.06	.05	-.18	-.02	.05
7.	1	.07	.00	.25a	.23a	-.22a	.11	.13
	2	.09	-.13	.31b	.24a	-.25b	.00	.11
	3	.03	-.02	.17	.28b	-.33b	-.10	.18
	4	-.13	-.10	.16	.22	-.32b	-.09	-.03

Table 5 (con't)

Correlations Between Memory Measures and Subscales of the MIA

T	Age Grp	Str	Task	Cap	Chan	Anx	Ach	Loc
8.	1	-.10	-.02	.05	.00	.01	-.03	.04
	2	.09	-.05	-.08	-.02	.04	.12	-.06
	3	-.06	.23a	-.03	.01	-.20a	-.04	-.05
	4	-.17	-.06	.03	.20	-.22	-.04	-.14
9.	1	-.07	.15	.10	.13	-.26b	-.14	.16
	2	.04	-.15	.02	.06	-.06	-.09	-.01
	3	.00	.12	-.03	.08	-.16	-.17	.03
	4	-.03	-.04	-.16	-.01	.03	-.20	-.20

Note. a = $p<.05$ b = $p<.01$

Age Group 1 = 54-61
2 = 62-68
3 = 69-75
4 = 76-93

T refers to the name of the memory test as outlined in Table 3.

tests are listed in Table 6.

Canonical Redundancy analysis suggested that the first metamemory canonical variate accounted for 32% of all MIA variance, and for 5% of all memory variance. The first memory canonical variate accounted for 31% of all memory variance and 5% of all MIA variance. The amount of variance shared by the the two canonical variates was 15%.

The first canonical correlation is an index of the degree of relationship between a weighted linear combination, or canonical variate, from the metamemory side and a weighted linear combination from the memory side. To investigate which variables on each side contributed the most to the canonical variate of that side (and thus to the overall canonical correlation), the correlations between the MIA subscale scores and their canonical variate and the correlations between the memory tests and their canonical variate were examined (see Table 7).

Anxiety was highly correlated with its canonical variate (r = -.7928). Change was also highly correlated (r = .7584). Capacity was moderately correlated (r = .5155) as was Achievement (r = -.4880). The canonical variate, then, appears to represent a factor which involves beliefs about self-efficacy in using memory (Hertzog, Dixon, Schulenberg, & Hultsch, in press).

Table 6

Standardized Canonical Coefficients

MIA	Standardized Canonical Coefficient
Strategy	.4007
Task	.1084
Capacity	.1023
Change	.4253
Anxiety	-.4357
Achievement	-.4907
Locus	.0865

Memory Test	Standardized Canonical Coefficient
AVLT Immediate Recall	.4032
AVLT Delayed Recall	-.3207
Visual Closure Del. Recall	.2997
Seq. Geo. Fig. Del. Recall	.2231
Supermarket Imm. Recall	.0598
Supermarket Loc. Recall	-.0617
Supermarket Del. Recall	.5232
Forward Digit Span	-.2823
Backward Digit Span	.4220

Table 7

Structure Matrix of Canonical Loadings

MIA Subscale	Canonical Loading
Strategy	.0407
Task	-.0589
Capacity	.5155
Change	.7584
Anxiety	-.7928
Achievement	-.4880
Locus	.3455

Memory Test	Canonical Loading
AVLT Immediate Recall	.6330
AVLT Delayed Recall	.4739
Visual Closure Del. Recall	.6550
Seq. Geo. Fig. Del. Recall	.5374
Supermarket Imm. Recall	.5705
Supermarket Loc. Recall	.3381
Supermarket Del. Recall	.7929
Forward Digit Span	.0878
Backward Digit Span	.5054

All the memory tests except for Forward Digit Span were related to the memory canonical variate. The Supermarket Delayed Recall Test was highly correlated (*r* = .7929), as were the AVLT Immediate Recall Test (*r* = .6330), and the Visual Closure Delayed Recall Test (*r* = .6551). The Supermarket Immediate Recall was moderately correlated (*r* = .5705), as were the Sequential Geometric Design Delayed Recall Test (*r* = .5374) and the Backwards Digit Span Test (*r* = 0.5054). This pattern of relatively high positive loadings seems to suggest that a general memory factor exists on the memory side. This would explain the appearance of only one significant canonical correlation.

The largest correlations between MIA subscale scores and the canonical variate of the memory tests were found with Anxiety (*r* = -.3126), and Change (*r* = .2991). Capacity was weakly correlated (*r* = .2033) as was Achievement (*r* = -.1925).

The largest correlations between the memory tests and the canonical variate of the MIA subscale scores were found with the Supermarket Delayed Recall Test (*r* = .3127), the Visual Closure Delayed Recall Test (*r* = .2584) and the AVLT Immediate Recall (*r* = .2496).

Age Differences in Metamemory/Memory Relationships. It was hypothesized that correlation patterns would differ by age groups. There is some suggestion of this in Table 5. To investigate age differences further, the 69-75 and 76-93 groups were combined to make the number of subjects comparable with the other two groups, and separate canonical correlations were done for each age group.

There was one significant canonical correlation for each age group (see Table 8). For the 54-61 and 62-68 year olds, Anxiety, Change and Capacity showed the greatest correlations with their canonical variate. For the 69-93 year olds, Anxiety, Change and Strategy showed the greatest correlations (see Table 9).

The patterns of correlations between the memory tests and their canonical variate for each age group separately were similar to the overall analysis. That is, almost all the memory tests loaded moderately to highly. The Self-Efficacy and General Memory factors, then, seemed to appear again when the analysis was done by age group.

It seems, then, that perceptions of memory as subject to long-term decline and higher anxiety in memory demanding situations play a role in memory performance throughout later adulthood. Perceptions of having a larger memory capacity are also related to performance amongst the young old, while strategy usage also appear to correlate with performance amongst the old-old.

Table 8

Canonical Correlation Analysis for Each Age Group

Age	n	R	Adj.R	R Squared	F	p
54-61	103	.54	.38	.27	3.827	.0004
62-68	106	.49	.36	.24	3.406	.0011
69-93	155	.43	.27	.19	3.728	.0003

Table 9

Structure Matrix of Canonical Loadings for the MIA by Age

Age	n	MIA Subscale	Canonical Loading
54-61	103	Anxiety	-.7261
		Capacity	.6978
		Change	.5933
62-68	106	Anxiety	-.7144
		Capacity	.6437
		Change	.6221
69-93	155	Anxiety	-.6281
		Change	.4019
		Strategy	-.3437

CHAPTER 5

DISCUSSION

I. Age, Sex and Order Differences in Metamemory

The present analyses suggest that there are age differences in late middle-aged and older adults' perceptions of their memory functioning. There also seem to be sex differences in such self-perceptions. No differences in metamemory scores were found for groups of individuals who completed the MIA before taking the battery of memory tests and those who completed it afterward.

Age differences were found on the Change subscale, a finding that seems robust across studies (Dixon & Hultsch, 1983b; Hultsch, Hertzog & Dixon, in press). Change, however, only accounted for 3% of the variance. Individuals in the 76-93 group reported that their memories have declined over the years, while the 54-61 group and the 62-68 groups saw their memories as relatively more stable. Mean scores for these latter two groups are similar to mean scores of the 55-61 and the 62-68 age group in Hultsch et al.'s (in press) study. They had found the most pronounced age differences when contrasts were drawn between young students and middle-aged and older adults, and that contrasts among the 55-61, 62-68 and 69-78 groups were not generally significant. Such results are consistent with the present study.

The present study marks the first time in research with the MIA that individuals in their 80s and 90s were included in a sample. Given that the 76-93 group scored significantly lower on the change subscale than the 54-61 year olds and the 62-68 year olds, and given that 55-61 and 62-68 year olds scored lower than young students in previous studies, there appears to be a change in perceptions of memory stability across the entire adult lifespan. Although this conclusion is based on cross-sectional data, it seems that the older people get, the more they perceive their memory abilities as declining. This change in perception may be based on veridical perceptions of actual declines in memory ability, or stereotypic expectations of deterioration of memory with age, or both.

This conclusion requires one qualification. In the present study, Change accounted for only 3% of the variance. This supports an earlier contention that age-related differences at the mean level within the middle-to older age ranges are fairly fragile (Hultsch, Hertzog & Dixon, in press). Discrepant findings in the literature, then, may be partially due to the nature of the subjects sampled in the later age ranges (Hultsch et al., in press).

Previous studies have found age differences on Capacity and Locus as well. Older persons reported having less memory capacity than young students reported having. Older persons have also been found to be more external and younger people more internal in terms of locus of control. No age differences were found on Capacity and Locus in the present study. The group means, however, closely resembled the means of Hultsch et al.'s (in press) 55-61, 62-68 and 69-78 year olds on Capacity but were slightly lower on Locus. Again, in the earlier studies, the age differences on Capacity and Locus were greatest when young students were compared with middle-aged and older adults.

The nature of the Capacity and Locus subscale items may be important in explaining age differences between students and older adults and the absence of age differences in a 54 and over sample. Capacity items (e.g., I am good at remembering names) and Locus items (e.g., Even if I work on it, my memory ability will go downhill) are broad, gross measures. They require subjects to summarize many experiences or feelings into a rating on a 5 point Likert-type scale ranging from agree strongly to disagree strongly. Although this scale might be sensitive enough to detect differences between the young, and the middle-age or old, it may not be sensitive enough to subtleties or specifics to differentiate amongst older groups.

In the present study, the 76-93 year olds reported that they place a greater importance on having a good memory and performing well on memory tests than the other groups do. Significant age differences in achievement motivation have never appeared before, but an over 76 group has never been studied before. While it is possible that achievement motivation in memory demanding situations increases in late adulthood, it is also possible that selection effects were present. These subjects were healthy, volunteers, and were not complaining of memory problems in their everyday life. This finding should be replicated before any conclusions are drawn.

Finally, no age differences on Strategy were observed. Hultsch, Hertzog and Dixon (in press) found that the old use more strategies than the young; Dixon and Hultsch (1983b) did not. Factor analysis of the MIA suggests that the Strategy subscale may have two subcomponents: use of internal mnemonic devices such as imagery, and use of external memory aids such as making lists. The old seem to rely more on external aids and the young on internal aids (Dixon & Hultsch, 1983b). Inclusion of questionnaire items of a more specific nature, asking about frequency of aid use and exact type of use (e.g., How many times a day/week do you use a date book?) may help establish more definitively whether age differences between the young and the old and amongst older groups exist.

Sex differences were found on Strategy, Capacity and Change. The report of greater strategy use amongst women is consistent with Hultsch, Hertzog and Dixon (in press). The higher capacity and change scores for women have not been seen before.

The present analyses found that MIA presentation order did not make a difference to metamemory assessments. The implication is that responses to the MIA are not so labile that they are influenced by having just performed memory tests or having memory tests pending. It cannot be determined yet whether MIA responses would be influenced by different memory experiences, however. These memory tests were fairly easy and designed to measure optimal performance. In addition, all subjects had already taken them one year earlier.

II. <u>Metamemory/Memory Relationships</u>

The present study suggests that there are relationships between specific metamemory subconstructs and specific memory tasks. These findings corroborate the argument that there is domain specificity in the metamemory/memory performance relationship across adulthood (Dixon, Hertzog & Hultsch, 1986).

The overall research question concerned the extent to which the MIA would be related to a battery of memory tests, some of which were traditional (e.g., AVLT, Digit Span) and some of which were based on a neuropsychological paradigm (e.g., Visual Closure Test, Sequential Geometric Design Test). The two data sets appeared to be related on one underlying dimension. Anxiety, Change and Capacity were the principle components of a Self-Efficacy factor on the metamemory side. The Supermarket Delayed Recall Test, the AVLT Immediate Recall Test and the Visual Closure Delayed Recall Test seemed to be the major contributors to a General Memory factor on the memory side. This finding was opposite to Dixon, Hertzog and Hultsch's (1986) results using the MIA and standard laboratory cognitive and memory measures, but was fairly consistent with Dixon and Hultsch (1983a) who used the MIA and text recall.

Given the differences in the general nature of the memory test batteries used in the present study and by Dixon et al. (1986), and given the domain specificity of relationships, it should not seem surprising that the best metamemory predictors differ between the two studies. The two batteries did, however, have several of the same tests or similar tests and the predictors still differed. For example, in the present study there were no significant correlations between any metamemory scores and Forward and Backward Digit Span. In contrast, Dixon et al. (1986) found significant correlations for young, middle-aged and older groups between Strategy and Backward Digit Span and Task and Backward Digit Span. This striking difference might perhaps be explained by sample and task differences. Dixon et al.'s (1986) middle-aged group consisted of 50 women ranging from 40-58 years old with a mean age of 49.48, and their older group had 50 women ranging from 60-78 with a mean age of 68.96. This explanation, however, is offered only very tentatively. This comparison underlines the need to use large samples of older people in order to attend to individual difference issues.

Alternatively, the amount of variability in scores on Backward Digit Span in the two studies may have differed. In the present study, Digit Span was administered according to the procedure outlined in the WAIS - R (Wechsler, 1981). Two trials on strings of numbers of the same length were given. The length of the string increased by one digit after each pair. Testing stopped when the subject missed both trials of a particular string length. In Dixon et al.'s (1986) study, however, all subjects attempted all strings, which were of varying lengths. It is possible that there was more variance in Dixon et al.'s data set, and thus, more potential for correlations to appear. Variance may have been restricted in the present sample. Unfortuantely, the standard deviation for this task in Dixon's sample is not known. Standard deviation for Digit Span Backward in the present sample was 1.29.

Another interesting comparison between the two studies can be made using Dixon et al.'s (1986) Word Memory scores and the AVLT measures in the present study. Dixon et al.

(1986) found significant correlations between Strategy and Word Memory for all three age groups and between Task and Word Memory for the oldest and youngest groups; the present study found no correlations between Strategy or Task and the AVLT Immediate Recall Test, and one isolated correlation between Task and the AVLT Delayed Recall Test.

Again, task differences may help explain differences in results. Dixon's Word Memory test was a paired-associate task. Subjects studied pairs of words that were highly asociated (e.g., black-coal). After a brief time delay, they were then given one member of the pair and asked to provide its mate. Success on such a task seems to require some sort of elaborative processing or strategy usage, and therefore, correlations with Strategy and Task are not so surprising. Again, variance in the subjects' strategy usage and task knowledge may also have been higher than in the present sample. This might be true for the AVLT Immediate Recall Test, whose standard deviation was 1.85, but perhaps not likely so for the AVLT Delayed Recall whose standard deviation was 3.15.

In the present study, Anxiety, Change, and sometimes, Capacity scores were related on numerous occasions to the Supermarket, the Visual Closure and the Sequential Geometric Design Delayed Recall Tests in particular. Each of these tests involved visual stimulus materials and modified instructions to facilitate encoding. Two of the three used familiar stimulus materials. Despite these features and deliberate attempts to minimize performance factors, there appears to be some feature about those tests that correlated with Anxiety in particular.

The Anxiety subscale consists of items that ask about how nervous the individual feels in memory-demanding situations. It measures individuals' perceptions of how stressful memory-demanding situations are for them. All significant correlations involving Anxiety were negative. This suggests that people who perceive that they are anxious in memory-demanding situations actually perform more poorly than people who do not perceive themselves to be anxious in such situations. In other words, people who perceive situations where they must use their memory as stressful seem to actually perform worse in those situations than people who do not perceive the situations as stressful.

The Change subscale assesses the extent to which individuals perceive that their memory is changing over time. A high score on Change reflects a perception of stability. People who perceived their memory to be relatively stable tended to score higher on the memory tests than those who perceived their memory as subject to long-term decline.

Anxiety and Change were moderately correlated with one another (r = -.53). That is, people who perceive that they are not anxious in memory-demanding situations are also people who perceive their memory to be stable, and people who feel they have a large memory capacity (the correlation between Capacity and Anxiety is -.47 and between Capacity and Change is .57). Possession of these memory resources, then, seems to be important to good performance.

The intercorrelations between Anxiety, Change and Capacity are consistent with Hertzog, Dixon, Schulenberg and Hultsch (in press), who investigated the factor structure of the MIA scale. They found some evidence to suggest that there are at least two higher order factors in the MIA. The first involves beliefs about self-efficacy in using memory. The second appears to combine knowledge about memory and affect concerning memory (e.g., achievement motivation). A separate affect dimension did not appear. The factor loadings for the second factor, tentatively labelled Knowledge, were invariant across young, middle and older adulthood. There were age differences, however, in the loadings for the Self-Efficacy factor.

Age Differences in Metamemory/Memory Relationships. Anxiety and Change seem to be related to performance throughout middle to late adulthood. Perceptions of having a high memory capacity also appear to predict performance for subjects under 69 but not for those over 70.

Capacity, however, is correlated with Change (r = .56), Anxiety (r = -.54) and Locus (r = .42) more strongly for the over 70 group than for any other. That Capacity was not a significant predictor for individuals over 70 may reflect these correlations with Change and Locus; that is, if people in their 70s and 80s believe that their memory is subject to inevitable age-related decline, then these individuals may stop believing that they have a reasonable memory capacity whether their actual capacity has changed or not. The absence of correlations between Locus and Capacity and performance for the over 70 group suggests that such beliefs might not influence performance.

Strategy, and possibly Task, start appearing as predictors in this sample at age 70. It is not clear whether this apparent shift reflects age changes or perhaps cohort differences. This shift, however, is logical. As capacity (objective or subjective) decreases, it must be replaced or compensated for. Increased strategy usage would be a good way to compensate.

These age differences are consistent with Hertzog et al. (in press). Their analyses found reliable age differences in the weights associated with the Self-Efficacy Beliefs dimension. Change and Locus related more highly to this factor in the old than in the young. Substantial differences in the loadings of the Change scale suggested there may be differences in the construct when young and old are measured. Perceptions of change were more highly associated with anxiety about memory and perceptions or reduced control over memory in the elderly than in the young (Hertzog et al., in press).

Future Research. More research is needed to demonstrate conclusively that there are two higher order metamemory factors, and that these factors are differentially related to performance. A factor analysis of the metamemory data from the present study would contribute to such a demonstration. Secondly, in future studies, individual difference variables besides age, sex and number of years of education should be considered as well as stimulus modality and stimulus familiarity.

III. Conclusions

Metamemory appears to be a multidimensional construct. Age differences were found on two of these dimensions, Change and Achievement. Change was an important predictor of memory performance at all ages, but Achievement was not. That is, although the 76-93 year olds, in particular, seemed highly achievement motivated, this motivation was not reflected in their actual performance. Rather, beliefs about memory self-efficacy and perceptions about anxiety in memory-demanding situations were important to performance.

Age differences in metamemory and in metamemory/memory performance relationships appear to be fragile. The age differences amongst the present were not overwhelming ones, but they contribute to the general understanding of how subjective perceptions of memory relate to actual memory performance in later life.

This was the first study on metamemory in adulthood to use exclusively middle-aged and older subjects and to include individuals in their 80s and 90s. It was also the first time Read's (1985) battery was used in empirical work. Whether the conclusions drawn using these measures and these subjects are robust will be determined by future replications.

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