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INVESTIGATING WORKING MEMORY AND METAMEMORY IN OLD AGE

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Abstract

An investigation of metamemory for working memory was conducted in a group of older adults aged 60 to 74 years using a variation of the Daneman and Carpenter (1980) reading span task. There were twelve trials in each experiment, with each trial containing six sentences. Participants had to assess whether each sentence was true or false as well as remembering the last word of each sentence in correct order. In Experiment 1 words were phonologically similar (rhyming) and dissimilar (non-rhyming), whereas Experiment 2 presented one syllable (short) words and two syllable (long) words. Half the participants were asked to predict how well they would remember the words and half were asked to postdict how well they had recalled the words. Participants were also asked to complete the Metamemory Functioning Questionnaire (Gilewski, Zelinski & Schaie, 1990) for a self-assessment of memory and this was compared to their memory performance on the recall task.

Results indicated that older adults recalled more rhyming words than non-rhyming words, and more short words than long words. They overestimated the number of non-rhyming words they would remember but their estimates fluctuated in the same pattern as actual recall for the rhyming and non-rhyming words showing some accuracy in their metamemory. However, people unexpectedly estimated that they would do better with long than short words. For long words postdictions matched recall better than predictions which showed that older adults were able to gather information about their performance during the task. There was no correlation between the MFQ scores and the recall accuracy of the memory task probably because the questionnaire measured more general aspects of everyday memory, whereas the recall task involved a single and very specific aspect of memory. When compared to the younger adults the older adults showed poorer recall performance and overestimation was larger for older adults. These results showed us that to some extent, older adults are able to estimate their memory performance, using metamemory in a complex memory task.

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Table of Contents

Abstract.....	ii
Acknowledgments.....	iii
Table of Contents.....	iv
List of Tables.....	vi
Overview.....	1
Introduction.....	3
Why does Memory deteriorate with Age?.....	4
Working Memory.....	6
The Atkinson-Shiffrin Model.....	6
Baddeley's Working Memory Model.....	7
How is Working Memory affected by Aging ?.....	12
Measurement of Working Memory.....	13
Metamemory in Older Adults.....	21
What is Metamemory?.....	21
Measurement of Metamemory.....	23
Offline Evaluation.....	23
Self-Efficacy.....	30
On-Line Evaluation.....	32
How does the Task influence Memory Results?.....	35
Do Older Adults use Strategies Effectively?.....	38
Summary.....	41
The Present Study.....	43

Method	46
Participants.....	46
Materials and Stimuli.....	47
Procedure.....	49
Results	53
Scoring and Overview.....	53
Experiment 1	54
Experiment 2.....	58
Memory Functioning Questionnaire Results.....	62
Age Effects- A Comparison of Results.....	64
Discussion	67
Working Memory Performance.....	67
Metamemory for Working Memory.....	70
MFQ Scores.....	72
Age Comparison.....	74
Limitations of the Present Study.....	75
Future Research.....	77
Conclusion.....	78
References	80
Appendix 1 Information Sheet.....	93
Appendix 2 True/False sentences used.....	95
Appendix 3 Response Sheet.....	98
Appendix 4 Memory Functioning Questionnaire.....	101
Appendix 5 Consent Form.....	103
Appendix 6 Health Screening Questionnaire.....	104
Appendix 7 Information Sheet at completion of session.....	105
Appendix 8 Results Letter sent to interested participants.....	107

List of Tables

Table 1	Mean viewing times and mean accuracy for true and false sentences as a function of word type in Experiment 1.....	55
Table 2	Mean for recall accuracy as a function of word type and time of estimate in Experiment 1.....	56
Table 3	Mean for predicted, actual, and postdicted recall as a function of word type in Experiment 1.....	57
Table 4	Mean viewing times, and mean accuracy for true and false Sentences as a function of word type in Experiment 2.....	59
Table 5	Mean for recall accuracy as a function of word type and time of Estimate in Experiment 2.....	60
Table 6	Mean for predicted, actual, and postdicted recall as a function of word type in Experiment 2.....	61
Table 7	Pearson correlation between MFQ scores and recall accuracy measures.....	63
Table 8	Experiment 1- Means for verification times of true/false sentences, recall accuracy for older and younger adults	64
Table 9	Experiment 2- Means for verification times, recall accuracy of true/false sentences for older and younger adults.....	65

OVERVIEW

There has been a sizeable amount of research that supports the commonly held view that memory deteriorates with age. However, the reasons for memory deterioration are not clear. They range from the optimistic view that poorer memory in old age arises from inefficient use of encoding and retrieval strategies, a problem subject to remedial intervention, to less optimistic views that declining memory ability is the consequence of irreversible age-related changes in basic mechanisms underlying cognition.

Much research has concentrated on working memory capacity in the elderly as there is a possibility that age-related changes in memory across the adult years arise from changes in fundamental processing mechanisms such as reduced ability to concentrate on a task, reduced working memory capacity or cognitive slowing. Working memory is used to describe the short-term memory system, which is involved in the temporary processing and storage of information. It is still to be determined whether older adults are limited by the storage capacity of their working memory, their efficiency of performing mental operations, especially complex tasks, or mental slowing. As working memory is potentially an underlying component of higher level tasks such as comprehension and problem solving, investigation of it is important. If working memory is not working effectively this will be more likely to be apparent in a complex task, requiring manipulation of information, when more demands are placed upon the system than in a simple task.

Research has also investigated metamemory. Light (1991) suggests that one of the factors contributing to age-related impairment in memory is the failure of metamemory. Metamemory refers to knowledge people have about what is demanded of their memory in different situations as well as strategies they use to cope with memory demands. This also includes beliefs about one's own memory abilities and self-knowledge about current memory use. If younger and elderly groups are using different strategies, then the difference in performance may be a result of these strategy differences rather than, or in addition to, capacity differences. Measurement of metamemory involves asking people to monitor their memory performance. They may be asked to predict how well

they will perform prior to completing a task or postdict how well they have performed once the task is completed. Studies have revealed inconsistent results when evaluating predictions of older and younger adults. Postdiction studies have been few but have found no age-related differences.

Brigham and Pressley (1988) hypothesized that developmental differences might be more certain in more demanding situations. The outcomes in their study suggest that life span changes in memory might be more obvious if complex memory tasks are studied. Declines in memory could be due to a number of changes in metamemory and interaction of metamemory with other factors.

It is therefore important to consider both working memory and metamemory when researching causes for age-related decrement in memory. There has been little research investigating metamemory for working memory. This study proposes to investigate metamemory for working memory in a complex task. It is important to complete a complex task study as there is the idea proposed by Baddeley (1986), that reduced memory capacity is available to the elderly when they have extra demands placed on them for storage and/or manipulation of information.

This study is a partial replication of a study by Richards-Ward (1996) which investigated metamemory for working memory in a sample of young adults. Comparisons will be made between the findings of the present study and the findings of the Richards-Ward (1996) study in order to determine whether there are age-related differences in metamemory for working memory.

INTRODUCTION

Most people in society agree that memory worsens with age. This view that aging is associated with memory loss probably leads to expectations of failing memory with age. Older adults complain more about memory than younger adults. There has been a lot of research to examine memory deficits in elderly people. In laboratory tests of memory, adults over 60 perform less well than adults in their 20's on free recall, cued recall, and recognition memory for lists of words or sentences (e.g. Burke & Light, 1982; Craik, 1977; Guttentag, 1985; Hertzog, Dixon & Hulstsch, 1990; Poon, 1985). However, on some recall tasks, elderly people have been more accurate than younger people. For example, in supplying information on survey questionnaires, people over the age of 60 were more accurate than people younger than 60 (Rodgers & Hertzog, 1987). It appears that age-related differences are found only among some people on specified tasks. The ability to gauge the accuracy of memory seems important for effective memory performance, as well as for competency on tasks performed without the use of memory aids. However, it has been difficult to account for normal memory changes because no single explanation is sufficient.

Research concerned with investigating the relations between adult age and measures of cognitive functioning has been termed 'Cognitive Aging'. This includes aspects of cognition that improve with age as well as those that do not. Most studies have concentrated on the decline of aspects of cognition in the age group of adults 20 to 80 years of age and often compare the abilities of younger and older adults to examine age-related decreases.

Research in this area often refers to processing resources, which can be defined as something that exists in limited supply and is responsible for the enhancing or enabling of certain cognitive processes (Salthouse, 1988). Working memory can be considered a processing resource in that it is presumed to have a limited capacity, and it is thought to be relevant to a great variety of cognitive tasks. Currently there is a lack of knowledge about the processing that is involved in specific cognitive tasks. This has been a disadvantage and has led to inconsistency with research that has attempted to develop formal models of cognitive aging phenomenon. Assumptions have been made that

processing resources are required for many cognitive processes and these are diminished as people get older. Conclusions have been drawn that older adults produce poorer performances in demanding tasks, as there is a reduction in the quantity of processing resources.

Why does Memory deteriorate with age?

Light (1991) proposed several reasons for the failing memory in the elderly. The most researched hypothesis is that there are changes in fundamental processing mechanisms such as reduced attentional capacity, reduced working memory capacity or cognitive slowing. Reduced attentional capacity focuses on themes about whether older adults are able to use strategies and learn or retrieve information under divided attention conditions. This also deals with the reasoning that only those aspects of memory that are demanding are impaired in old age while those aspects that are automatic do not affect memory. The relationships among attentional, working memory capacity and speed conceptualisations of processing resources are complex and it is often difficult to distinguish among them. An unresolved issue, according to Light (1991), is whether the principal limitation in working memory in old age is storage capacity, efficiency of performing or managing sequences of operations, ability to perform mental operations while simultaneously preserving the products of intermediate operations, or mental slowing. Assumptions underlying both attentional and working memory explanations of cognitive impairment in old age are that older people have fewer processing resources than younger people to deal with memory tasks. Light concludes that this explanation can account for some of the age-related differences in memory, but not all.

Another hypothesis for age-related impairment in memory, according to Light (1991), is failure of metamemory. This is important for the present study. Light implies that older adults may not remember as well because they are less likely to use the appropriate strategies to perform tasks proficiently, or because they monitor their encoding and retrieval processes less effectively. In addition, memory skills may become difficult to use if not practiced. However, numerous studies summarized by Light (1991) and Salthouse (1991) conclude that elderly and young adults report using similar memory

strategies. Younger and older adults are equally skilled in memory monitoring with the possible exception that older adults may not be as good at gauging their test-readiness. It has been found that in some conditions older adults perform less well than younger ones but they are better in others. There is as yet no adequate explanation for this pattern of results.

Older adults may have incorrect beliefs about memory. When they age, they may assume their memory will fail and behave with anticipated poor memory. They then remember less, experience reduced feelings of self-efficacy and so on. However, evaluation of the view that age-related decrements in memory stem from lowered self-efficacy is premature, given that the appropriate causal links have yet to be established between memory beliefs and performance in the old. In fact, the reasons for age-related memory impairments have still to be determined. Although there have been numerous studies conducted, especially in the area of working memory, these have resulted in discrepant findings with conflicting experimental outcomes and lack of clarity about the concepts involved.

The present study examines tasks using working memory and also investigates metamemory as a possible explanation for the cause of memory decline in the elderly. The following section discusses the working memory concept and reviews issues from previous working memory research of the elderly.

WORKING MEMORY

According to Salthouse (1992), "Working memory is the hypothesized mental work region where new and old information interact to create new products"(p.39). Working memory is used to describe the short-term memory system, which is involved in the temporary processing and storage of information. Although the concept of working memory has its roots in the more traditional and constrained concept of short-term memory, it appears to be successfully developing into a much broader model of the crucial interface between memory and cognition. Working memory now differs from older notions of "short-term memory", primarily in an emphasis on the manipulation of information, rather than on simple storage (or maintenance).

The question of whether memory should be regarded as a single unitary system or whether it should be divided into two or more subsystems formed one of the major controversies within cognitive psychology during the mid 1960's. Some of the most convincing evidence, for a two-model, came from the study of brain-damaged patients. People suffering from the classic amnesic syndrome appeared to have gross disruption of the capacity to form new lasting memories but showed preserved performance on a range of tasks that were assumed to test short- term memory. Conversely a second type of patient was identified who appeared to show normal long-term learning but had a short-term memory span limited to one or two items (Shallice & Warrington, cited in Baddeley, 1992). This argued for a two-model view of memory such as that proposed by Atkinson and Shiffrin in 1968.

The Atkinson-Shiffrin Model

Atkinson and Shiffrin (1968) proposed that material firstly arrives from the senses to sensory memory where it passes to short-term memory. From short-term memory material is more likely to pass to long-term memory if it is rehearsed frequently and kept longer in short-term memory. Without rehearsal material can be lost from memory within about 30 seconds. Atkinson and Shiffrin proposed that verbal information in

short-term memory is encoded acoustically by people in terms of its sounds. People use strategies to remember information such as rehearsal or silent repetition.

The Atkinson and Shiffrin model appeared initially to solve many of the problems of conceptualizing the memory system. However, it was found by Baddeley and Hitch (1974) that it was particularly difficult for the model to accommodate the evidence from patients with short term memory deficit, as such a deficit should have led to gross impairment in long-term learning and to problems in cognitive performance in general. No such deficit occurred. Therefore, they proposed, instead a multi-component working memory model controlled by a limited-capacity attentional system, termed the Central Executive.

Baddeley's Working Memory Model

Baddeley (1986) described working memory as "a system for the temporary holding and manipulation of information during the performance of a range of cognitive tasks such as comprehension, learning and reasoning" (p.34). According to Baddeley and Hitch (1974) there are three components of the Working Memory Model.

1) Central Executive

The central executive component is the most important. It is the most complex and misunderstood component of working memory. Its functions include the regulation of information flow within working memory, the retrieval of information from other memory systems such as long-term memory and the processing and storage of information. Baddeley proposes that the central executive works like a supervisor and decides which issues need attention and which should be ignored. It also selects strategies and works out how to tackle problems.

The efficiency with which the central executive fulfils a particular function depends on whether other demands are placed on it at the same time. The greater the competition

for the limited resources of the executive, the more its efficiency at fulfilling particular functions will be reduced. Placing two demanding tasks together is thought to exceed the capacity of the central executive system, resulting in mutual interference between tasks, with a subsequent deterioration in performance. There is the idea that lower capacity in the central executive constrains performance in the elderly by placing limits on storage and/or manipulation of information.

The central executive system controls the functioning of the separate storage mechanisms, the main ones being the phonological or articulatory loop system and the visuospatial sketchpad.

2) The Phonological Loop

According to Baddeley's model the Phonological Loop is capable of processing and maintaining verbal information and consists of a phonological short-term store and a subvocal control process used for rehearsal and recording information into phonological form. The verbally coded information maintained will be lost within two seconds unless the material is rehearsed. In this it differs from long-term memory which appears to rely more on semantic than acoustic coding (Baddeley, 1966). It is thought that the phonological loop accounts for the phonological similarity effect, the word length effect, the recency effect and the effect of articulatory suppression (Baddeley, 1992).

Phonological Similarity

As the material is coded acoustically, items that sound the same are also confused with one another and are more readily forgotten. This phonological similarity effect was first reported by Conrad and Hull (1964), who found that immediate recall of a list of items is much poorer if the items are phonologically similar to one another, than if they are phonologically distinct. They showed that sequences of letters that are hard to discriminate when heard in noise (e.g. CBGPTV) are retained much less accurately than easily discriminable sequences (e.g. RXQHKW) even though they are presented

visually. This phenomenon has been found over many studies to be robust. In contrast, immediate memory performance shows little sensitivity to the semantic similarity of the memory list (Baddeley, 1966). Baddeley (1968) suggests that the acoustic similarity effect occurs at retrieval and is due to the overloading of retrieval cues.

The Word Length Effect

Studies have split the phonological loop into a phonological short-term store and an articulatory rehearsal mechanism (Baddeley, 1992). These two components contribute substantially to retaining verbally encodable material in short-term memory. The articulatory rehearsal mechanism recycles verbally encoded material to refresh the memory trace of material residing in the phonological short-term store. The word length effect refers to the observation that immediate memory span declines systematically with the spoken length of the items remembered (Baddeley, Thomson & Buchanan, 1975). This is assumed to occur because long words take longer to rehearse than do short words, allowing more time for the memory trace of earlier words to fade away before they can be revived through active rehearsal. People can generally remember about as many words as they can say in two seconds. The size of the word length effect is a measure of the efficiency of the articulatory rehearsal mechanism.

Avons, Wright and Pammer (1994) conducted experiments using auditory and visual presentations of lists consisting of five long or short words. Their results particularly those with visual presentation, cast doubt on the idea that word-length effects originate in rehearsal alone. They suggested that some, if not all, word-length effects arise during output, possibly by decay during output, by restrictions imposed by a limited-capacity output buffer, or by output interference. Longer words take longer to reproduce, leading to a greater delay between presentation and test, particularly of late items.

Caplan, Rochon and Waters (1992) report a failure to observe the poorer immediate serial recall for words of longer spoken duration observed by Baddeley et al. and subsequently replicated by others. It appears to be the case that words showing a clear difference in articulation time when spoken clearly and slowly show little difference

when articulation is speeded- presumably because the words become truncated, for example, "balloon" becoming "bloon". It is therefore unsurprising that the Caplan et al. material fails to show a significant memory advantage for the more rapidly spoken items. Caplan et al. concluded that the phonological structure of words, not their articulation time, was responsible for the word-length effect.

Recency Effect

Glanzer and Cunitz (1966) found that when people were presented with a list of unrelated words to recall in any order immediately, they tended to remember the last few items very well in contrast to earlier items, which were less likely to be remembered. This recency effect disappeared when people were distracted from remembering for a few seconds by some other task, such as counting, but memory of the earlier items remained the same. Reasons for the recency effect are controversial. Crowder (1982) suggests that auditorily presented material represents a trace or sensory residue that can be accessed at recall. Baddeley's (1986) explanation is that an automatic retrieval strategy is used in which the last items are accessed first.

Articulatory Suppression

It is possible to disrupt the use of subvocal rehearsal by requiring subjects to utter some repeated irrelevant sound, such as the word "the". Immediate memory span is then reduced. This process, known as articulatory suppression, prevents people from rehearsing the material they are trying to remember and thus removes the effect of word length. Suppression also prevents people from registering visually presented material in the phonological store. The store is then irrelevant to performance. Phonological similarity or the corrupting of the store with irrelevant speech has no effect. It removes the phonemic similarity effect only when stimuli are presented visually and not when they are spoken (Baddeley, Lewis, & Vallar, 1984). Whereas the word length effect is due to rehearsal processes, the phonemic similarity effect arises within the phonological store.

The Effects of a Phonological Loop Deficit

People with a specific phonological loop deficit seem to have remarkably few signs of general cognitive impairment. Although they typically have difficulty in comprehending certain types of complex sentences, interpretation of results in this area remains controversial (Vallar & Shallice, 1990). The most commonly held view is that the phonological store serves as a backup system for comprehension of speech under taxing conditions but may be less important with simple, clearly presented material (Baddeley, 1992).

3) The Visuospatial Sketch Pad

The Visuospatial Sketch Pad is the third component of Baddeley's working memory model and is involved in the short-term processing and maintenance of material which has a strong visual or spatial component. This component again is assumed to involve a brief store, together with control processes responsible for registering visuospatial information and for refreshing it by rehearsal. Matlin (1994) suggests that it is used in much the same way that a pad of paper helps to work out a geometry problem. As it has a limited capacity, when too many items are supplied, they will not all be successfully recovered and errors will occur.

The limits of the phonological loop and the visuospatial sketchpad are independent. As Baddeley and Hitch (1974) discovered, numbers can be rehearsed in the phonological loop while decisions are made about the spatial arrangement of letters on the visuospatial sketch pad. Their research in the area of the visuospatial sketchpad was undertaken to find out the role of visual imagery in verbal memory. People were shown a 4 x 4 matrix, with one square marked as a starting square and then asked to listen to and repeat back sequences of sentences describing the location of digits 1-8, a technique devised by Brooks (1967). It was found that people were able to remember the sentences by creating an imaginary path through the matrix, which they remembered as a pattern and were able to reproduce the sentences based on the pattern. There is,

however, rather less evidence as to the nature of this encode and refresh mechanism, and nothing equivalent to the word-length effect in phonological memory has so far been discovered. Research by Logie (1986) found that encoding may be disrupted by presenting irrelevant visual items such as pictures or colour patches with accompanying spatial processing. A study by Baddeley and Lieberman (1980) found that disruption occurs even when there is no visual input. They used blindfolded people who were unable to use a visual imagery mnemonic when they were required to track a moving sound source.

As in the case of the phonological loop, there is evidence for an involvement of the sketchpad in long-term memory. When Logie (1986) conducted research presenting colour patches, as mentioned previously, that interfered with verbal paired-associate learning, based on visual imagery people were still able to learn by verbal rote rehearsal. The assumption that the sketchpad is a work-space, for holding and manipulating visuospatial information, suggests that it may serve a wide range of functions. However, as yet, there has been little in the way of systematic exploration and suggestions remain somewhat speculative.

How is Working Memory affected by Aging?

Adult age differences in measures of cognitive functioning are often attributed to age-related limitations in working memory (Hartley, 1986; Light & Anderson, 1985; Stine & Wingfield, 1987; Stine, Wingfield, & Poon, 1986; Welford, 1958).

The limitations of working memory might affect the quality of performance if the solution to a task requires a greater amount of simultaneously available information than that which can be maintained within the constraints of an ineffective working memory system. Daneman and Carpenter (1980) devised a test with heavy processing and storage demands to assess whether individual differences in reading comprehension reflect differences in working memory capacity, specifically in the trade-off between its processing and storage functions. A good reader would have fewer computational

demands on working memory; hence more capacity for storing the necessary intermediate and final products of the reading process. The processing and storage components of the test, called the reading span test, involved the visual demands of sentence comprehension. An additional storage component required people to maintain and retrieve the final words of sentences. Research on memory development has argued that a major difference between good and poor readers is the efficiency of their processing, rather than static memory capacity. An important feature of many cognitive activities is that early information must be temporarily preserved while other information is being acquired or manipulated. Older adults may therefore be impaired in cognitive tasks, because compared to young adults they have less of the relevant information available when it must be integrated or evaluated to make a decision.

However there is still no consensus about the nature of working memory, or more specifically, the aspect of working memory that is most affected by age. Efforts to use indexes of working-memory capacity as predictors of age-related differences in memory have met with only moderate success. The proportion of age-related variation in performance attributable to working-memory capacity is small enough (probably less than 50%) to discredit strong versions of the hypothesis that working-memory differences are the sole mediators of performance decrements in old age (Salthouse 1988, 1990; Salthouse et al., 1988).

There has been a lot of research measuring the memory capacity of working memory in an effort to determine the age-related differences in memory. The following section examines this research and the methods used to measure the efficiency of working memory.

Measurement of Working Memory

The efficiency of working memory can be measured by:

- 1) Measuring the efficiency of processing with concurrent storage,
assessed in units of efficiency or time.

- 2) Measuring the capacity of storage with concurrent processing, assessed in units of number of items remembered.

Speed of Processing

James Birren (1974, cited in Salthouse, 1992) was the first theorist to promote the idea that a slower speed of processing might be an important causal factor in the adult age differences in many aspects of cognition. Speed of processing might exert its effects on cognition by altering the functioning of working memory. There is strong evidence that older people are especially penalized when the task is paced or when responses must be made within a given time limit (Welford, 1958, 1977).

Salthouse and Babcock (1991) discussed two possible mechanisms for the influence of speed on working memory. These were that increased age might be associated with more rapid loss of information or with a slower encoding or activation of information. It was concluded by Salthouse (1992) that "the processes responsible for the relations among age, speed and working memory seem to involve the speed at which relevant information can be activated, and not the rate at which information decays or is displaced" (p.168). No explanation is available yet for why increased age is associated with slower motor and perceptual speed. According to Salthouse (1988) empirical efforts to demonstrate that memory decrements in old age stem either solely or in large measure from cognitive slowing have not met with much success.

Salthouse and Coon (1993) conducted two studies using older and younger adults to investigate the aspect of processing involved in the hypothesized speed mediation of adult age differences in memory. The studies involved a serial memory task in which information was to be recalled immediately either in the original order of presentation or in a reordered sequence (numerical order with digit stimuli and alphabetical order with letter stimuli). Of particular interest was the condition in which reordering of the stimuli was required because the subjects were completing a working memory task and working memory has been implicated as an important factor in age differences in cognitive tasks (Salthouse, 1990). The age difference might be expected to be larger

with the recall in reordered sequences if the older adults show less efficient processing. However, when processing demands were increased the overall age differences were not significantly larger. Results also confirmed earlier findings of a large influence of processing speed on adult age differences in memory.

Salthouse (1994) conducted further research to show processing speed plays an important role in the adult age differences in Working Memory. Studies consisted of paper and pencil tasks requiring same/different judgements about the physical identity of pairs of letter strings (letter comparison task) or pairs of line patterns (pattern comparison task). Performance in each task was measured by the number of items completed within a fixed amount of time. A digit symbol and digit-digit pairing computer task also assessed processing speed. Age-related variance in working memory was greatly weakened after controlling for speed. A further study involved participants deciding whether a particular letter-digit pair had been recently presented together. It was found that older subjects required considerably more time than younger adults to achieve similar results, but the amount of decrease in accuracy with intervening items was generally similar for young and old adults. It therefore appears that the speed influence occurs because older adults are slower than young adults at encoding information or establishing an adequate internal representation, and not because of an age difference in the rate at which information is lost over short intervals.

Dobbs and Rule (1989) conducted a study of a spatial memory task, involving the presentation of digits, which required constant updating and manipulation of processing. They found that there were significant declines between the ages of 60 to 69 and 70+ years. They suggested that a very important aspect of the aging process is a decline in the agility with which processing changes can be accomplished. This agility notion differs from a speed of processing (Salthouse, 1985) interpretation in that it is not speed of processing per se, but the speed or agility of accomplishing changes in processing that is focal. Aging may have a pronounced effect on the agility notion and a lesser or negligible effect on more passive (storage) aspects of memory.

Salthouse (1993) considered that successful performance is determined by several abilities and therefore it is possible that the same level of performance could be

achieved with different combinations of abilities. For example, if older adults have a greater amount of knowledge than young adults in a particular domain, then it might be expected that they would rely on this knowledge to compensate for any age-related declines in processing efficiency that might have occurred. If successful performance is primarily dependent on speed, then the age effects can be expected to be quite large, as is evident in the digit symbol task. However, if knowledge is an important aspect of the task, as in most of the criterion verbal tasks examined in these studies, then the age effects can be expected to be much smaller. Age differences are reduced in tasks with moderate to large knowledge involvement because the average level of one performance determinant (knowledge) tends to increase with age at the same time that the average level of the other performance determinant (speed) tends to decrease.

Processing and Storage Capacity

Reference to working memory as a limited capacity system implies that the more processing capacity that is required for any one working memory process, the fewer processing resources will be available for the performance of others. Age differences are expected to be larger when the working memory requirements are increased because the consequences of greater demands placed on an ineffective working memory system should be more pronounced than those resulting from the same demands placed on an effective working memory system. An important feature of a task assessing working memory is that it must require the maintenance of some information during the processing of that or other information. There has been a lot of research studying the age-deficit in working memory processes when elderly adults are presented with tasks that place demands on working memory systems.

Welford (1958) suggested that a primary characteristic of increased age was a reduced ability to retain information in memory while simultaneously processing the same or other information. Obviously, if older adults are less effective than young adults at simultaneously processing and storing information, then this limitation of working memory would likely lead to lower levels of performance on all tasks that make those

requirements. But are age differences in working memory attributable to age differences in storage capacities, reduced efficiency of processing, or reduced efficiency in updating, indexing or more generally controlling information in working memory?

Some studies have attempted to separate deficits in processing from deficits in storage. In two experiments, Cohen (1981, cited in Foos, 1989) examined reasoning in young and older adults. Cohen pointed out that older individuals performed poorly even in a written condition in which materials were always visible. As such a condition is assumed to place minimal demands on the storage resources of working memory, differences in performance between young and older persons were attributed to a deficit in processing.

Foos (1989) supported the hypothesis of a smaller working memory storage capacity for older participants. A mental addition task found that elderly participants performed quite well and not significantly different from younger participants when they were required to put three items in order. However, four items and five items were more difficult for older participants. Wright (1987, cited in Foos, 1989) has found that when individuals must allocate limited capacity to competing processes, such as rehearsal of digits for later recall and verbal comprehension of sentences, performance is lower in elderly individuals. To separate processing from capacity, she pointed out that with a small demand on storage capacity, older and younger persons did not differ, but as the demand on capacity was increased, the older participants were more affected than the younger. Differences may be due to less efficient allocation of the same resources in the elderly or to the ways in which both groups process information.

Craik and Rabinowitz (1985) felt that elderly adults are particularly penalized by fast presentation rates and that age deficits are reduced considerably if older people are given sufficient time. They conducted research to ascertain whether the age-related deficit is attributed to insufficient processing time or an age-related deficit in the type of processing operations carried out. This involved young and old adults who studied several lists of words at each of three presentation durations (1.5, 3 and 6 seconds per word). The magnitude of age-related recall deficit increased with longer presentation durations. Craik and Rabinowitz argued that one major factor underlying age

decrements in memory is the failure of elderly adults to carry out effective processing operations, unless the processes are guided by environmental supports during learning and retrieval.

Salthouse (1987) suggested a distinction between structural capacity and operational capacity. Structural capacity might refer to the number of distinct informational units that can be remembered at any given time, whereas operational capacity could indicate the number of processing operations that can be performed while still preserving the products of earlier operations. These two types of capacity are differentially sensitive to age. Structural capacity remains relatively invariant across adulthood whereas operational capacity appears to decline with increased age. The key characteristic of operational capacity is simultaneous storage and processing. Results from a task requiring the integration of successfully presented line segments into a composite stimulus, revealed that there were little or no age differences in structural capacity but large age differences favouring young adults in operational capacity.

Slightly greater age differences have been found in versions of the task requiring more concurrent processing. Babcock and Salthouse (1990) contrasted the performance of younger and older adults over several studies in simple and complex tasks, and found that older adults were less accurate generally than young adults, especially with the complex tasks. Salthouse, Babcock and Shaw (1991) conducted eight experiments in which young and older adults were asked to report the latest value of one of several continuously changing numeric or spatial variables. Accuracy of reporting the current value of the target variable was lower with increases in the number of potentially relevant variables and with increases in the number of required processing operations. Again the older adults were less accurate than the young adults.

Salthouse and Skovronek (1992) administered a cube comparison test in which participants were required to determine whether drawings of cubes with letters in varying orientations on each face represented the same cube. Older adults, relative to young adults, exhibited greater reductions in accuracy as the processing requirements increased. They also made significantly more redundant or repetitive requests for information while also preserving the products of earlier processing.

However, it does not seem to be the case that age differences always increase as the amount of required concurrent processing increases, and the results have not been completely consistent when age comparisons are made after equating participants on the amount they can remember in immediate span tasks. A study by Desroches, Kaiman and Ballard (1966) assessed the relationship between age and recall of meaningful material over various retention intervals. They felt that short-term memory deficits reported in previous studies might be due to differences in learning rather than differences in retention. The older and younger people learned a list of nine words. After people had reached the learning criterion of one correct trial, both the older and younger groups were equally divided in random order into one of four recall periods: - 15 min., 1 hr., 1 day, and one week. The finding that age did not influence recall scores suggests that differences in retention reported in the literature for the aged were probably due to differences in learning rather than differences in retention.

A study reported by Baddeley, Logie, Bressi, Della Sala, and Spinnler (1986, cited in Light, 1991) compared young and old adults in simultaneous visual-motor tracking and digit span performance. The level of tracking difficulty in this study was adjusted to produce the same range of performance for each individual, and then that level was administered while the participant was also attempting to remember sequences of digits equivalent in length to his or her previously established ability. Unlike the Salthouse et al. (1984) experiments, older adults in this experiment did not exhibit any greater performance impairment than young adults with the requirement of performing two tasks concurrently.

The literature reviewed shows that it is difficult to make definite conclusions about the nature of working memory, or more specifically, the aspect of working memory that is most affected by age. It has been reported that age differences remain constant as processing demands are varied (Baddeley et al., 1986, cited in Light, 1991). There is evidence for the age-complexity effect. This is the phenomenon of older adults exhibiting greater performance decrements than young adults with increases in the processing demands or complexity of the task (Salthouse, 1985, 1988; Salthouse et al., 1989 cited in Salthouse & Skovronek, 1992). Babcock and Salthouse's (1990) research

did not support the prediction that greater performance impairments might be expected for older adults than for younger adults as processing demands are increased. However, they conducted a meta-analysis of results from several studies and found that when viewed as a group contrasts revealed greater processing costs for older adults than for younger adults. Age differences were found in the simple versions of tasks presumed to have minimal processing requirements as well as the complex tasks. They concluded that age-related differences in both storage and processing components seem to contribute to age-related differences in working memory.

It appears that both storage and processing components are important when researching age-related differences in working memory. Therefore, the present study proposes to use a task based on the Daneman and Carpenter (1980) sentence-span task which has both storage and processing complexity. This may involve both the phonological loop and the central executive. The present study will also investigate the hypothesis that the phonological similarity effect and the word-length effect will be present in this complex-span task.

Previous studies by Baddeley involving the phonological loop (Baddeley et al., 1984; Baddeley et al., 1975; Baddeley, Lewis, & Vallar, 1984 ; Conrad & Hull, 1964;) have found that in recall there has been both a word-length and phonological similarity effect. This study will investigate the hypothesis that the phonological similarity effect and the word-length effect will be present in this complex-span task. It will examine the ability of older people to predict the accuracy of their recall and also compares older people to a young student group completing the same task. If older adults are less effective than young adults at simultaneously processing and storing information, then the limitation of working memory would likely lead to lower levels of performance on all tasks that make those requirements.

The next section will describe the concept of Metamemory. This is first defined and then followed by a consideration of the different ways that metamemory is measured. Research is considered in relation to the accuracy of older adults in using their metamemory and how their self-efficacy and the strategies they use affect this.

METAMEMORY IN OLDER ADULTS

What is Metamemory?

Researchers studying metacognition, that is, awareness of cognitive functioning, have become interested in how older adults, in particular appraise their ability to remember (Perlmutter, 1978). Research on metacognition has focused on memory. This research is referred to as metamemory. Flavell (1971) used this term to describe a person's knowledge of memory awareness, in particular knowledge of the memory demands imposed by different tasks or situations as well as strategies that might be used to improve memory in these situations (Flavell & Wellman, 1977). Cavanaugh and Perlmutter (1982) defined the term metamemory as systemic awareness, which is awareness of facts about memory, in other words, awareness of the memory system and how it works. There are several types of metamemorial abilities, two of which were described by Flavell & Wellman (1977). The first type, memory monitoring, is the ability to assess the status of items currently in the memory. For example, this type includes knowledge about whether an item has been stored in memory and can be recalled. Another type of metamemory, memory knowledge, consists of various facts that a person could know about memory in general. An example is the knowledge that concrete nouns are easier to recall than abstract nouns. Another important component of metamemory is the awareness that in order to remember something, then some form of effort is required in executing particular strategies (Flavell & Wellman, 1977). Monitoring refers to the appropriate use of strategies and whether people are able to decide which strategies are suitable for certain tasks. Memory monitoring in adulthood has been the object of study more often than has memory knowledge, the other type of metamemory. A variety of skills for monitoring memory are used when people store, retain and retrieve in the memory process. The efficient memorizer is seen as analyzing the task in light of abilities and then selecting an appropriate strategy, if one is needed to optimize performance. Metamemory includes knowledge of mnemonic strategies (for example, rehearsal and visual imagery) and the amount of effort required in executing particular strategies. One general strategy is to use an external memory aid, which is defined as any device, external to the person, that facilitates memory in some way

(Intons-Peterson & Newsome, 1992 cited in Matlin, 1994). External memory aids include a shopping list and a bookmark. As well as knowledge about strategies, metamemory also encompasses memory self-efficacy, that is, beliefs about one's own memory abilities.

Metamemory has come to be of interest because of its possible role in explaining age-related differences in the use of memory strategies. If one doesn't know important information about the memory task, available strategies to deal with it, or one's abilities and capabilities, it would be very difficult to select an appropriate strategy. Furthermore, if one failed to adequately monitor or test the outcomes of one's strategies, then revisions in strategies required for optimal performance could not be carried out. An important strategy is the time taken for tasks. In the context of metamemory researchers have assessed whether people have the ability to allocate more time to the more difficult tasks and whether they are aware of their test readiness. That is, it is assumed that people will put in enough time to study effectively so that when tested they will be able to correctly remember the information they have studied.

A common technique for operationally defining metamemory in the early developmental literature was prediction of memory task performance (Schneider, 1985). Memory predictions were often conceptualized as an index of knowledge about one's own memory (Cavanaugh & Perlmutter, 1982; Schneider, 1985). Cavanaugh (1989) interpreted predictions as an aspect of awareness of memory functioning, a construct closely tied to the concept of memory monitoring (knowledge about current memory use, contents, and states). A common procedure is to give participants a description of a task with examples, or limited experience with the task, followed by a request to predict performance. The central question is usually whether there are age differences in the accuracy of performance predictions.

It should be kept in mind that metamemory is not a single element of knowledge that older adults have or don't have. It is a complex constellation of facts about capacity, tasks, strategies, and their interactions (Cavanaugh & Perlmutter, 1982; Dixon & Hultsch, 1983; Flavell & Wellman, 1977). It also involves knowledge about the current state of the memory system that can be gained only concurrently with task performance.

As there is a great deal of variability in defining the term metamemory it is important to look at the different ways in which memory is measured.

Measurement of Metamemory

Awareness of memory can take three forms: systemic awareness (awareness of facts about memory), epistemic awareness (awareness of the validity of knowledge), and on-line awareness (awareness of ongoing memory processing). The three categories highlight the point that we are aware of different aspects of memory and that they may have different developmental courses. There are three ways used to determine people's awareness of their memory and how it works. The first is offline evaluation of memory ability, which asks people for a universal assessment of their memory as it affects their everyday lives. The second is online evaluation, which involves people performing a memory task and being asked to evaluate their performance, such as the number of items they will remember or how well they have remembered specific items. The third form of metamemory measurement looks at monitoring skills and people's knowledge concerning skills needed to remember information. Research involving older adults is interested in whether older adults use strategies effectively and whether further training can enhance memory performance.

1) Offline Evaluation

Memory Questionnaires

Systemic awareness involves information that can be put into the form "I know that". This is the kind of awareness that is routinely assessed in memory questionnaires and metamemory interviews. Typically, a questionnaire is used to assess a person's metamemory ability. There have been several different self-report questionnaires developed for the self-appraisal of metamemory. These are identified and described in

the following section.

Why are memory Questionnaires used to assess the memory of older adults?

There are four reasons why questionnaires are useful in assessing the memory of older adults. First, research conducted by Zelinski, Gilewski, and Thompson (1980) found reliable correlation between the memory complaints of healthy elderly persons in the community and their memory performance. Secondly, memory complaints provide information for researchers on how people view their general cognitive functions as they age. Thirdly, they may also be helpful in detecting the early signs of a dementing disorder or differentiating between dementia and depression. The fourth reason is that investigations have demonstrated significant associations between complaint and depression (Larrabee & Levin, 1986; West, Boatwright & Schleser, 1984; Williams et al., 1987). Although memory self-rating questionnaires are useful they also have their limitations. This will be discussed later in this section after a brief outline focusing on some of the main metamemory questionnaires used.

Metamemory Questionnaire (MQ)

The Metamemory Questionnaire (MQ) was developed by Zelinski, Gilewski and Thompson (1980) to evaluate people's perception of their everyday memory functioning. It consisted of 92 items requiring a 7-point scale judgement on various aspects of everyday remembering and forgetting. Responses to the MQ are made on nine categories: General Rating of Memory, Reliance on Memory, Retrospective Functioning, Frequency of Forgetting, Frequency of Forgetting When Reading, Remembering Past Events, Seriousness of Memory Failures, Mnemonics Usage, and Effort to Remember.

The MQ has been used to investigate several major questions on the usefulness of assessing self-appraisals of memory functioning. Studies have reported relationships between MQ scales and depression (Blau, 1986 cited in Gilewski, Zelinski & Schaie, 1990; O'Hara, Hinrichs, Kohout, Wallace & Lemke, 1986; Popkin, Gallagher,

Thompson, & Moore, 1982; Williams et al., 1987), and in several cases between MQ scales and performance on some memory tasks (Blau, 1986, cited in Gilewski, Zelinski, & Schaie, 1990; Williams et al., 1987). The MQ was refined as it was identified that investigators were only using several of the scales in their work due to its excessive length and the fact that the scales weren't able to be summed into a total score easily. The shortened version of the MQ was renamed the Memory Functioning Questionnaire (MFQ).

Metamemory in Adulthood (MIA)

Dixon and Hultsch (1984) used the MIA to investigate several constructs including the following as listed: -

- use of memory strategies (Strategy scale)
- knowledge of memory tasks and processes (Task scale)
- memory and state anxiety (Anxiety scale)
- achievement motivation and memory (Achievement scale)
- awareness of change in memory (Change scale)
- knowledge of one's own memory capacity (Capacity scale)
- locus of control in memory abilities (Locus scale)

The factors of the MIA have been analyzed to assess whether they measure separate factors representing memory self-efficacy (self-appraisal) and knowledge about one's memory performance in general or whether separate factors for strategy, affect and change appear (Hertzog, Dixon, Schulenberg & Hultsch, 1987; Hertzog, Hultsch, & Dixon, 1989). This analysis has produced mixed results. It was found that there were four correlated factors- General Frequency of Forgetting, Seriousness of Forgetting, Retrospective Functioning and Mnemonics Usage, which accounted for 36.7% of the variance in responses to the MQ. Dixon and Hultsch (1983) advised that they had designed the MIA to be multidimensional and not representative of a single construct of metamemory. Research (Hertzog, Hultsch & Dixon, 1989) was conducted to examine the construct validity of the MIA and MFQ. It was found that they overlapped in

measures of memory self-efficacy, perceived change in memory functioning and measures of self-reported memory strategies (principally, use of external memory aids).

The Memory Assessment Clinics Self-Rating Scale (MAC-S)

The MAC-S was developed by Winterling, Crook, Salama, and Gobert (1986). They addressed the constraints of the existing questions on scales, such as those identified by Herrmann (1982) and Gilewski and Zelinski (1986) which included vague and often negative wording of items and failure to consider the complex multivariate nature of memory. The MAC-S consisted of 102 items describing specific memory tasks or problems encountered in everyday life. These were divided into two sub-scales of equal length featuring ability and frequency of occurrence. People were asked to assess their ability to remember specific types of information (for example, "the name of a person just introduced to you"). Responses were recorded on a 5-point scale, which ranged from very poor (1) to very good (5). The frequency of occurrence scale ranked the responses of people who were asked to assess how often specific memory problems occurred in situations (for example, "forget what you intended to buy at a grocery store or pharmacy"). Responses were recorded on a 5-point Likert scale, ranging from very often (1) to very rarely (5). The advantages of the MAC-S include the brevity of the scale, the wide range of memory self-report factors, and a large normative base that covers the adult range of 18 to 92 years.

The Memory Functioning Questionnaire (MFQ)

The Memory Functioning Questionnaire MFQ is a shortened version of the MQ (Gilewski, Zelinski & Schaie, 1990) developed to assess the self-appraisal of everyday memory functioning in adults. It was considered a less threatening way of assessing cognitive functioning than laboratory memory tests, which produce more anxiety. The MFQ consists of 64 items rated on 7-point scales from which four unit-weight factor

scores are calculated:

- General Frequency of Forgetting- includes ratings of how often forgetting occurs in 28 specific situations, including when one is reading, as well as 5 additional ratings of one's memory performance in general.
- Seriousness of forgetting- ratings of memory failures from 18 different situations.
- Retrospective functioning- ratings of change in current memory ability relative to 5 points earlier in life.
- Mnemonics usage- the frequency with which 8 specific mnemonics are used.

Internal consistency of the factor scores is high, with alpha values ranging from .94 to .83. Mean factor scores for a normative sample of 590 adults aged 50-89 years were 151.08, 84.26, 18.14 and 30.15, with possible totals of 231, 126, 35, and 56, respectively. Higher scores reflect higher levels of perceived memory functioning, with fewer forgetting incidents, less serious incidents, improvement in current memory ability relative to earlier in life, and less use of mnemonics. MFQ factor scores have been shown to reflect variance other than that caused by chronological age, education, or self-reported health status (Gilewski et al., in press).

Zelinski, Gilewski & Anthony-Bergstone (1990) completed research to determine whether MFQ factor scores when the effects of depression, health status and education have been accounted for, are related to memory performance. They concluded that there is a degree of concurrent validity for the MFQ with respect to laboratory memory tasks in a sample of normal adults because it reliably predicted performance on list memory tasks after the effects of subject background variables previously shown to affect scores were partialled out. However, the relationship between MFQ factor scores and memory performance scores is modest. As expected, people who reported more frequent memory failures also performed more poorly on the clinical tests. The MFQ factors producing reliable data in all the analyses predicting performance on the clinical memory tests were Frequency of Forgetting and Seriousness of Forgetting.

The MFQ has been chosen for use in the present study because, although not a strong predictor of memory performance, it is better than people's affirmations that they have memory problems. Only approximately 4% of the variance in memory scores was accounted for by such responses to an inquiry, and the MFQ accounted for 31% to 23%

additional variance in performance. As indicated by Zelinski et al. (1980) a psychometric measure is preferable to simply questioning individuals when assessing their memory abilities. Although significant metamemory-memory task performance relationships are not always found, most studies using text recall tasks have detected significant relationships of text recall with questionnaire measures of memory self-efficacy (e.g. Cavanaugh & Poon, 1989; Dixon & Hultsch, 1983; Sunderland, Watts, Baddeley, & Harris, 1986; Zelinski et al., 1980). Zelinski et al. (1980) and Cavanaugh and Poon (1989) reported significant memory self-efficacy relationships with both text recall and word-list recall. Perhaps the need to recall information from text materials occurs relatively often in everyday life, enhancing the accuracy of self-efficacy beliefs. The shortened version of the MFQ makes it user friendly and this was considered to be an important factor when dealing with older people who were also completing a complex task on a computer.

Limitations of Memory Questionnaires

It appears clear that there are multiple dimensions of metamemory. The dimensionality of the metamemory construct is a central issue in evaluating the validity of metamemory questionnaires. Distinctions are made between knowledge about memory mechanisms, processes, and failures and beliefs about one's own memory abilities, strengths, and weaknesses (Hertzog, Hultsch, & Dixon, 1989).

Previous researchers, for example, Gilewski and Zelinski (1986) and Herrmann (1982), noted that in developing questionnaires validity has provided a challenge because memory function self-report and actual memory task performance has frequently been quite low. These researchers also criticise questionnaires for non-specific, negative wording of items and inadequate normative data. Herrmann (1982) points out that in most published comparisons, individuals' subjective self-report questionnaire scores have not predicted their objective performance on simple laboratory tasks. He observes that the reasons for this could be that the questions on the memory questionnaires do not resemble the memory performance tests and fail to cover the many facets that comprise

the complex phenomenon of memory.

In evaluating self-report questionnaires experimenters have become aware that people answering these questions can only make comparative, and not perfect, judgements about their own abilities, and about changes in their abilities over time (Rabbitt & Abson, 1990). A problem, which is perhaps especially acute in age comparisons, is that individuals with poorer memories are more likely to 'forget that they forget' and so underreport their lapses (Rabbitt & Abson, 1990). Also, socially conditioned beliefs about the nature of cognition or about individual differences might lead older people to overestimate the amount of their actual decline in function or perhaps to focus their attention on particular kinds of lapses. The self-report questionnaires currently in use survey the number and variety of lapses reported but not the reasons that people make them. The probable cause of lapses would be more useful in analysing possible functional changes underlying difficulties the elderly experience in their daily lives. It is not possible to gain specific information from the self-report questionnaires as ratings are totalled to give overall scores. Therefore different individuals may obtain the same score with totally different patterns of lapses.

As people get older, it is likely that radical changes in life-styles will alter the kinds, as well as the numbers of difficulties they experience. They may also become aware of the same everyday memory failures that they have experienced all their lives. Early research (Zelinski et al., 1980) showed that it was often only older adults that admitted having memory problems. They had lower scores on the 'General Frequency of Forgetting' and 'Retrospective Functioning' scales than the younger adults did. It was also noted that those with greater education reported more use of mnemonics.

Another problem with the total scores on self-report questionnaires is that they may reflect individual differences in confidence and self-regard as well as differences in memory ability. As depression and reduced self-esteem may become increasingly common in later life this may affect age comparison scoring. Although there has been little research in this area some researchers (for example, Bandura, 1981, cited in Berry & West, 1993) have speculated that elderly adults may be likely to underestimate their abilities, particularly in the intellectual domain. It is important therefore to consider

self-efficacy theory as underestimation of abilities can have detrimental consequences for performance.

Self -Efficacy

The self-efficacy concept was introduced by Bandura (1977, cited in Berry & West, 1993) who defined this as "people's judgements of their capabilities to organise and execute courses of action required to attain designated types of performances"(p.353). This self- evaluation is linked to a particular task and can change depending on the task demands, the situation, individual development and social context. Judgements about one's own ability are often made under stressful conditions. People may be asked to evaluate performance in an unknown environment. Evaluation is sometimes based on past performances, which in turn influence further judgements and future performance.

Several studies from adulthood and aging literature provide support for efficacy/performance relationships. According to Bandura, (1986, cited in Berry & West, 1993) self-efficacy has predictable effects on a variety of task engagement variables (for example, persistence, effort, goal setting, strategy usage, and choice) that mediate the relationship between self-efficacy and performance. Bandura (1986, cited in Berry & West, 1993) states that with people, " the stronger their perceived self-efficacy the more vigorous and persistent are their efforts"(p.394). When they achieve substandard performances, people who have self-doubts about their capabilities slacken their efforts or abort their attempts prematurely. Conversely, those who have a strong belief in their capabilities, exert greater effort to master the challenge (Bandura & Cervone, 1983; 1986; cited in Bandura 1989).

Numerous studies have also shown that performances are improved if individuals visualise themselves performing successfully (Bandura, 1986; cited in Bandura, 1989). People who believe strongly in their abilities visualise success scenarios, which provide positive guides for performance, whereas those who judge their memory as poor will have self-doubts and be erratic in their thinking. An hypothesis advanced by Borkowski et al. (1990, cited in Devolder & Pressley, 1992) was that those believing memory performances were controllable would use more strategies and remember more than those believing memory performances were out of their control. It has also been

hypothesised that younger and older adults may differ in beliefs about memory and strategic processing, and that these beliefs can motivate memory efforts and strategy use, and ultimately influence memory performance (e.g. Devolder et al, 1990; Devolder & Pressley, 1989).

Devolder and Pressley (1992) tested younger and elderly adults on four memory tasks: recall of word lists, recognition of words, face-name learning, and appointment keeping. People were also required to choose from four alternative reasons for their performance: ability, effort, item difficulty, and luck. The older adults believed that ability was more important for performance than strategy use and thought they would never get 80% or 100% correct. It was interesting to note that they were more confident with the familiar appointment-keeping task and with this task used more strategies and outperformed the younger adults. It was also found that within both age groups the participants who believed that their memory was determined by effort and strategy performed better than those who did not believe they had control over their memory ability.

In relation to memory in the elderly, lower self-evaluations based in part on negative social expectations, can lead to poorer memory performance through their indirect impact on decreased effort, less use of adaptive strategies, avoidance of challenging situations and failure to seek medical attention for disease-related symptoms of forgetfulness. It has recently been suggested that older adults who observe changes in their own memory or believe that memory declines are inevitable and irremediable may develop lower self-efficacy with respect to memory. This will lead to poorer performance, as they may not try as hard as younger adults to remember. A self-fulfilling prophecy then evolves with poorer performances leading to reduced memory and lower feelings of self-efficacy, and so on.

Strong converging evidence points to a poorer sense of memory self-efficacy in older adults relative to younger adults. This effect has been obtained across MIA memory self-efficacy scores (Cavanaugh & Poon, 1989; Hertzog et al., 1990; Hultsch, Hertzog, Dixon & Davidson, 1988). However, the MIA self-efficacy sub-scales rated poorly as predictors of memory performance in a study by Hultsch, Hertzog and Dixon (1984). As memory questionnaires have not always provided reliable results in relation to memory

performance, other memory measures must be considered for judging metamemory. The second way of monitoring metamemory is online evaluation. This will be discussed in the following section.

2)Online Evaluation

Online evaluation is a useful tool for discovering whether individuals are successful at monitoring the effectiveness of their processing operations for storing and retaining memory material. This may develop a better understanding of effective storage strategies. Online awareness refers to one's conscious knowledge of what one is currently thinking about. Online evaluation would involve estimations made in close proximity to, and specifically about, task performance.

Predictions and Postdictions

There are two major ways that performance estimates are obtained. One technique requires that people estimate how well they think they will perform on a task prior to actually doing it. In the other method estimates are obtained from the participants after they have performed the task. Metamemory is assessed by comparing the person's actual performance with their estimate of how well they think they will perform the task (prediction), or how well they have performed the task (postdiction).

There should be little difference in either prediction or postdiction inaccuracies as a function of age if monitoring, which is measured by prediction and postdiction, remains the same across the life span. Alternatively, if monitoring declines during adulthood, then the accuracy of predictions, postdictions, or both would be expected to worsen as people aged; if it improves during adulthood the accuracy of predictions, postdictions, or both would improve with increasing age. There is contradictory evidence regarding age deficits in metamemory tasks, especially when people are asked for prediction and

postdiction assessments. As the present study will involve both predictions and postdictions from older adults, these will be examined in more detail.

Predictions

Performance predictions are based on an individual's specific belief about his or her own memory ability in familiar situations and also on a global memory self-efficacy belief. In making predictions people must consider knowledge from previous tasks and remember which strategies they had used and how well they had worked. The individual must also be able to understand the task required in order to estimate performance. Inaccurate performance predictions can arise when an individual is not able to accurately assess the memory task required or, alternatively, has incorrect beliefs about his or her own memory ability. For example, overestimation of performance by older persons could reflect overconfidence in ability, underestimation of task difficulty, or both.

How accurate are older adults at predicting memory performance?

Several studies researching the accuracy of predictions made prior to actually performing the task have concluded that older adults overestimate how well they will do. That is, older adults typically predict that they will be able to remember more items than they actually do. A study by Murphy et al. (1981) showed participants sets of line drawings. They were asked to indicate when they believed they had reached the serial recall span for the line drawings and then tested to assess the accuracy of their prediction. This was followed by further tests involving longer lists and unlimited time to study. When predicting the number of items they would recall younger adults tended to underestimate whereas older adults overestimated. The older adults were also less likely to use more time to study the harder lists, whereas the younger adults recognised extra time was needed for the more difficult tasks.

An overestimation by the aged of the amount they would recall was also found by Bruce et al. (1982). They studied adults of three age ranges (18 to 31, 60 to 69, and 70 to

79 years) and asked them to predict how many words they would be able to remember from a 20-item list. Participants were shown four examples of the types of words before making their predictions. Their predictions were then compared with their actual performance. The conclusions drawn were that the young adults had more accurate memory knowledge than the older adults.

Lovelace and Marsh (1985) studied the memory of 20 young and 20 old adults in a matching task, which involved 60 word pairs. A prediction measure was taken for the likelihood of the person recalling the pairs. Young adults were correct on 50% of the pairs and the older group was only correct on 30%. Again, the older group overestimated the number of correct matches they would make and the researcher concluded that this group had underestimated the task difficulty.

However, non-developmental aging research does not support the overestimation finding. Camp, Markley, and Kramer (1983) found that if older adults were asked to think about strategies they might use to improve performance they tended to underestimate their abilities. This research involved asking older adults to predict how successful they would be at remembering words from a list containing fifteen items.

Berry, West and Scogin (1983, cited in Cavanaugh, 1989) also found that on both laboratory and everyday memory tasks the older adults underestimated performance, although they did find that accuracy was better for everyday tasks. Berry et al. found that there was a correlation between prediction accuracy and performance of .60. The people with the best on-line awareness (metamemory) were also the best at memorizing words.

Shaw and Craik (1989) found no age differences for predictions in a recall task. Participants were given different words with descriptors (initial letters, rhyme, and category) which were given during encoding and then again when participants were trying to remember the words. They were also asked to predict how accurate they would be at remembering the words. Although there was a difference in their memory performance both groups were accurate in predicting their performance in remembering the words. Shaw and Craik suggest that the lack of an age difference in predictions

indicate that older participants make the same predictions they would have made when they were 20 years old. Perlmutter (1978) also found no significant differences between the memory predictions of young and old adults when asked to predict ability to remember words and factual, general information questions.

Research by Rabinowitz et al. (1982, cited in Lovelace & Marsh, 1985) involved younger and older adults studying 50 word pairs for 10 seconds each. When time was up they were asked to predict if they thought they would be able to remember the target word for each pair on a later test if provided with a cue word. Predictions were made on a 10-point scale. Data collected led these researchers to the conclusion that "the metamemory results were remarkable in their complete absence of any age-related differences" and summarised that, "there is no support here for the conclusion offered by Murphy et al. (1981), that older adults are deficient in their memory monitoring skills"(p.694).

There may be substantial differences within age levels in motivational beliefs, habits and affect, which may be more powerfully related to realistic monitoring than age differences per se. The data discussed previously raise the issue of whether there are consistent age differences in memory awareness even for particular tasks.

How does the task influence memory results?

There are many distinctions one can make regarding the tasks and component processes, which may influence the type of results achieved for young and older adults. Tasks may differ in whether they require overall versus item-specific evaluations, prospective versus retrospective evaluations, self-monitoring versus task monitoring or evaluations at encoding versus evaluations at retrieval. Task familiarity has been hypothesized to play a role in age differences in monitoring (Balcerak & Rebok, 1986; cited in Devolder & Pressley, 1989; Lovelace & Marsh, 1985) such that age groups would be more accurate on tasks with which they were more familiar. Similarly, Lachman and Jelalian (1984) observed a correlation between predictions and

performance, such that younger and older adults were more accurate in monitoring tasks on which they as a group excelled with respect to performance. That is, people may be aware of when they are performing well but have less awareness of performance deficiencies. They found that elderly people tend to overestimate their performance prior to engaging in a task and then become more accurate by lowering their assessments on subsequent trials, indicating they are more accurate when aware of the task requirements. This suggests that it may be easier to make the estimations when the task is familiar, or after the task has been completed. Estimations after the task has been completed are called Postdictions . These are considered in the next section.

Postdictions

How accurate are the Postdictions of Older Adults?

There has been little research in the area of postdiction accuracy with older adults, as most researchers appear to have concentrated on awareness of memory as reflected by predictions about future performances. An additional aspect of memory monitoring, however, is the ability to derive more accurate performance expectations on the basis of awareness of recent performance levels. An excellent indicator of this type of monitoring is decreased inaccuracy from prediction to postdiction. Research in the area of postdictions has generally found people are more accurate with postdictions than predictions. This makes sense as for most tasks with predictions people are guessing how well they will do from general observations whereas they can base their postdictions on the task they have just completed. However, when predictions are repeated, as in the present study, people are able to base them on their previous experience in performing other trials. In this case they are not so different to postdictions although the memory of performance will still be clearer in the case of postdictions as the postdictions follow immediately after the memory task.

Older adults appear to perform as well as younger adults on postdicting tests. Research by Devolder, Brigham and Pressley (1990) examined three samples of older and

younger adults across a variety of memory tasks to evaluate the developmental course of monitoring abilities. Performance awareness was measured either before study of materials or after taking the test. Neither age group was consistently better at monitoring memory performances than the other age group. All quantitative age differences occurred in the prediction condition; no significant age differences in inaccuracy were observed in postdictions. In the data reported there were moderate-sized improvements in accuracy from before study to after test for both the younger and older subjects. Similarly, research by Perfect and Stollery (1993) conducted tests with three groups of older adults aged 50-80 years old to monitor ongoing memory processes. People were shown lists of forname-surname pairs and asked how well they had remembered the information. Again, there were no age differences in the accuracy of retrospective memory evaluations. Lovelace and Marsh (1985) also conducted similar research with 20 young and 20 old adults using 60 'unrelated' paired words. Both groups were able to accurately postdict their memory responses.

However, Brigham and Pressley (1988) and Hanley-Dunn and McIntosh (1984) have found age-related differences in postdiction accuracy. Brigham and Pressley (1988) conducted a study to examine cognitive monitoring and strategy choice in younger and older adults. People were given a list of vocabulary words to learn and two different strategies to use. The older adults' postdictions on the key-word-item task were less accurate than the younger adults, and they underestimated their performance. Research by Hanley-Dunn and McIntosh (1984) presented names from one of four list conditions (elderly-relevant, young-relevant, both-relevant, non-meaningful) to 56 young and 56 old adults. The old adults performed as well as the young adults overall and recalled significantly more names than did young adults for the elderly-meaningful (big bands) list and both-cohort meaningful (national politicians) list. As expected, young adults recalled significantly more of the young-meaningful (contemporary singers) list items. The older adults performed as well as the younger adults on the non-meaningful list. Despite these generally equal or better levels of recall, the elderly adults rated their own perceived performance lower than did the young adults.

The difference between prediction and postdiction inaccuracies may have critical implications for many aspects of thinking processes. Postdiction accuracies are useful as

tools for developing awareness of future memory potential. For example, if people are aware that they are more accurate with their postdictions than predictions, they may consider their accuracy in task performance and the strategies they used to obtain a greater accuracy. Training can concentrate on memory performance awareness and skills required to increase performance.

If memory monitoring is to benefit a person, then it should have an effect on the strategies a person selects while studying. When processing is controlled, the real effect of memory monitoring is not allowed to surface. If processing is uncontrolled by the experimenter, then strategy production deficits produced by a failure of memory monitoring are possible. If people are accurate at monitoring, decisions will be made about whether more effort is required to remember details or whether different strategies should be used to achieve better results. When studying memory it is important to consider memory-enhancing strategies as these affect performance.

3) Do Older Adults use Strategies Effectively?

The study of metamemory provides insight into memory development across adulthood and may have a possible role in explaining age-related differences in the use of memory strategies. When applied to the study of age-related impairments in memory, Light (1991) proposes the metamemory perspective gives rise to several hypotheses. First, older adults have incorrect beliefs about their memories and the strategies to use and therefore their memories decline. Also, their memories are likely to be poorer as they are less likely to use the right strategies for completing tasks and fail to monitor the processes they use to remember material effectively. Older adults may be prevented from using strategies effectively as they may lack processing speed or may not have the necessary knowledge about their memory to adopt a strategy spontaneously. Alternatively, they may not understand the memory task fully or their ability and

potential, and therefore fail to select an appropriate strategy. If performance is not monitored adequately after using strategies then performance will not be improved with the use of revised strategies. If young and elderly groups are using different strategies, then the difference in performance may be a result of these strategy differences rather than, or in addition to, capacity differences.

Identifying the conditions that support or facilitate encoding and retrieval are particularly important in helping older adults to remember information. If the person wishes to simply hold information in primary memory, rehearsing or repeating the words or letters is a useful strategy. However, elderly persons may spend their time on more rehearsal than is necessary for a good performance. Adults can be asked, after an experiment, to list the strategies they used to remember the information. Performances can be compared between those that used strategies, such as rehearsal, and those that completed the task without the use of strategies.

Increased age is frequently associated with greater amounts of experience, which might lead to broader and more extensive knowledge. If the elderly have learned a large repertoire of strategies for memory efficiency they may continue to use them to perform at remarkably high levels in familiar memory tasks. However the disuse view according to Light (1991), states that "memory-enhancing strategies are required less as people move further away from the educational system" (p.335). It has also been found that older adults may experience some difficulty in acquiring knowledge about the efficacy of new strategies (Brigham & Pressley, 1988). Especially with laboratory-type memory tasks, older adults tend to show poorer memory performance and fail to produce the kinds of effective strategies that young adults adopt spontaneously.

Research by Brigham and Pressley (1988) hypothesized that developmental differences might be more evident in more demanding situations. They observed a clear developmental decline in awareness of performance when younger and older adults were asked to learn vocabulary words using either an imagery strategy or a sentence strategy; the latter involved creating a meaningful sentence for the word, a strategy that was unfamiliar to the participants. The participants were required to alternate their use of these strategies, using imagery for one item, then sentence generation, then imagery,

etc. Consistent with their expectations, Brigham and Pressley observed clear developmental decline in awareness of performance. Before the experiment, neither younger nor older adults realized that the imagery strategy was a better approach to vocabulary learning. After using the two strategies and being tested on the materials learned with the strategies, the younger adults were aware that the imagery method led to better performance whereas the older adults found it hard to determine the best strategy to use. The outcomes of this study suggest that if complex monitoring tasks are studied, changes between older and younger adults in the use of strategies and the influence this has on results obtained may be more obvious.

One area of growing interest is memory training with the elderly. Research shows that the elderly often do not spontaneously use encoding strategies, but they can use them when instructed or reminded to do so. When trained or instructed to use strategies the performance of older adults tends to improve, sometimes dramatically (Schmitt, Murphy & Sanders, 1981; Sterns & Sanders, 1980 cited in Murphy, Schmitt, Caruso, & Sanders, 1987). Murphy, Sanders, Gabriesheski, and Schmitt (1981) conducted two experiments, which compared the performance of older and younger adults with a recall readiness task. The first experiment allowed unlimited study time for the recall of pictures and the task difficulty was individually adjusted. It was found that the younger adults were more accurate and took longer to study the pictures. They were more likely to have tested themselves before indicating their readiness to proceed with test recall. The second experiment compared three groups. One group was given strategy training (chunking and rehearsal). The second group was instructed in memory techniques. A third group had to take as much time to study the task as the young adults in the first experiment. The older adults who were forced to take extra study time were the most accurate. Strategy training led to better memory recall than just instructions about remembering. When the older adults were told to memorize only, then they tended to rehearse less and recalled fewer items than the younger adults. Murphy et al. suggested age differences showed when there was a difficult task requiring more time. The older group did not realise they had to spend more time on the more difficult task to recall more items.

It has also been found that adults with higher verbal abilities are often better at

remembering test information. A higher verbal ability may be related to more elaborate encoding of information and also deeper levels of processing. In addition, according to research by Perlmutter (1978), high-verbal people may engage more frequently in verbal activities" such as reading" that require the use of memory.

Summary

This section has discussed metamemory in older adults, as beliefs about memory and memory awareness may be more important in determining memory performance than actual memory ability. Self-perception of memory may affect expectations, use of strategies or effort to remember and hence memory performance.

The evidence to date favours the conclusion that monitoring differences between younger and older adults are not very great. There is contradictory evidence from research examining the predictions of memory performance in older and younger adults. Some researchers found older adults overestimate how well they will do (Bruce et al. 1982, Lovelace & Marsh, 1985; Murphy et al. 1981). Other researchers found that the older adults underestimated their performance (Berry, West & Scogin, 1983, cited in Cavanaugh, 1989; Camp, Markley & Kramer, 1983). Some researchers found no age differences in the predictions of young and old adults (Perlmutter, 1978; Shaw & Craik, 1989). There has been little research dealing with postdictions although older adults appear to perform as well as younger adults on tests involving postdictions (Devolder, Brigham & Pressley, 1990; Lovelace & Marsh, 1985). Overall, the data suggested no consistent age effects in performance awareness. Age differences in monitoring occurred only in predictions and only for some tasks.

Devolder et al. (1989) examined age differences in the frequency of over versus underestimates. This hypothesized developmental difference was significant on only two of the ten tasks examined. A substantive interpretation of the discrepant findings is that age differences are more likely on some tasks than on others. General conclusions cannot be drawn with confidence from any one study, and drawing conclusions across

studies is difficult because of population, procedural, and analyses variability. Devolder, Brigham and Pressley (1990) suggest that overpredictions might be attributable to memory perceptions not keeping pace with actual memory deterioration. Underpredictions might reflect older adults internalizations of negative stereotypes about memory decline with aging (Rodin & Langer, 1980).

However, these explanations would not account for different age patterns in inaccuracies across tasks. Other explanations might: Task familiarity has been hypothesized to play a role in age differences in monitoring (Balcerak & Rebok, 1986, cited in Devolder & Pressley 1989; Lovelace & Marsh, 1985) such that age groups would be more accurate on tasks with which they were more familiar. Lachman and Jelalian (1984) found that younger and older adults were more accurate in monitoring tasks on which they excelled with respect to performance; that is, people may be aware of when they are performing well but have less awareness of performance deficiencies.

It has been hypothesized that self-efficacy can affect memory performance. It is conceivable that older adults have a poorer sense of memory self-efficacy in relation to younger adults. Another possible explanation for age decrements in memory is that the elderly do not use memory strategies as often or as efficiently as do younger adults. Brigham and Pressley (1988) suggested that life span changes in monitoring might be more obvious if complex monitoring tasks are studied.

Overall, there is little support for hypotheses that failures in metamemory are responsible for age differences in memory. There are few studies that compare different metamemory measures in the same conditions and relate these to memory performance.

THE PRESENT STUDY

Studies reviewed indicate an age decrement in memory, which may not be determined solely by primary memory capacity. As already determined, there are many factors that change with age that may also have an effect on memory performance. It is conceivable that age-related differences in metamemory may contribute to memory deficiency between older and younger adults. As already stated, there has been little research investigating metamemory for working memory, although studies have been conducted by Richards-Ward (1996), Baken (1998), and Bunnell, Baken and Richards-Ward (1999).

The present study is a partial replication of a study conducted by Richards-Ward (1996), but uses older adults. It specifically investigates the metamemory for working memory of people in the age range of 60-74 years and examines the effects of word length and word similarity in a complex span task. The complex-span task used is a variant of the Reading Span task (Daneman & Carpenter, 1980). The Daneman and Carpenter (1980) sentence-span task has been used in experiments and also chosen for this study as this task requires participants to process information and at the same time memorize words. In this task participants are required to read a series of sentences. After each sentence is presented, participants have to say whether it is true or false. After the entire set of sentences has been read, the participants are required to report the final word of each sentence in the original order. The task constrains the participants to simultaneously process each sentence and hold the set of final words in mind for recall. Baddeley (1984), has suggested it involves "strategy selection, the phonological loop and a knowledge of vocabulary as well as the capacity to co-ordinate these various aspects of memory" (p.138). Therefore this may involve both the phonological loop and the central executive.

The aim of the present study is to examine the ability of older adults to predict their own working memory operation. Predictions, postdictions and time allocation are used to index metamemory. It will be interesting to compare the accuracy of predictions and postdictions. Previous research by Devolder et al. (1990) found postdictions were better

than predictions for young and old adults. It is expected that if people are able to monitor their memory performance they will be more accurate with postdictions, as they are based on the task just completed. However, when making a prediction people will be guessing how well they are going to recall the words, with their estimate based on minimal information. Hence, they may decide to make a safe guess by responding around the mid-point of the scale. As shown from the research already examined there have been mixed results from studies researching performance awareness before study of materials or after taking a test. Some studies have found that when older adults make predictions prior to performing a task they overestimate how well they will do (Bruce et al., 1982; Lovelace & Marsh, 1985; Murphy, 1981). Berry, West and Scogin (1983, cited in Cavanaugh, 1989) found older adults underestimated performance and also found that people with the best metamemory were also the best at memorizing the words.

The first hypothesis regarding the outcome of the study is that there will be greater recall of phonologically dissimilar than similar items. As mentioned previously, it has been found that items that sound the same are also confused with one another and are more readily forgotten (Baddeley, 1968; Conrad & Hull, 1964). Conrad and Hull (1964) also found that when items are phonologically similar there is a greater tendency to interchange them in recall. This is important to note as the present study assesses the ability of participants to predict or postdict their actual recall of words in correct order.

The second hypothesis regarding the outcome of the study is that there will be a word-length effect, that is short words will be recalled better than long words. This effect, which has been observed by Baddeley, Thomson and Buchanan (1975) and subsequently replicated by others, is attributed to the fact that long words take longer to rehearse than short words. Other research (Morris, 1984) has found that phonological similarity and word length effects are still evident in older adults.

The Metamemory Functioning Questionnaire will be used to evaluate people's assessment of their memory ability and will be compared to their memory performance. This is included to explore whether a general questionnaire is related to a specific task. Gilewski and Zelinski (1986), and Herrmann (1982) found that the correlation with

memory function self-report and actual memory task performance has frequently been quite low.

This study also compares older people to a young student group completing the same task. If older adults are less effective than young adults at simultaneously processing and storing information, then the limitation of working memory would likely lead to lower levels of performance on all tasks that make those requirements. As a complex task has been chosen for this study it is likely that the younger adults will outperform the older adults. Research has found that age decrements become more evident with increases in the processing demands or complexity of the task (Salthouse, 1985, 1988; Salthouse et al., 1989, cited in Salthouse & Skovronek, 1992). It is expected that older adults will take longer to perform the task and young adults will recall more words than old adults, as this has been found by previous researchers (Kausler & Puckett, 1979; Salthouse & Babcock, 1991).

No hypotheses have been made about the accuracy of either predictions or postdictions of the older and younger adults. It is not possible to draw definite conclusions from previous research. As discussed previously, inconsistent results have been found with respect to postdictions, and research examining predictions has not reached any clear conclusion. The present study aims to examine further the predictions and postdictions of older adults within working memory.

METHOD

Participants

Participants were recruited from the local community in Nelson, New Zealand. Information about the study was made available to subjects in the age group of 60 - 74 years. The Information Sheet was distributed to people in this age group, by friends of the researcher, to enable them to assess what would be expected of them, and whether they wished to participate in the experiment. When people participated in the research they were asked to pass on information to their friends and further people were recruited by this snowballing effect. People who were interested in participating in the study contacted the researcher by telephone or e-mail, or registered their interest in the study by leaving their name and contact details with a friend to pass on to the researcher. The researcher contacted the people interested in participating in the study, who had been given the information sheet (see Appendix 1), and answered their initial questions about the research. The participants were asked at this initial contact if they wished to complete the experiment and if they agreed an appointment was made.

There were 51 participants in total, 26 females and 25 males. However data were only used for 48 participants, as one female withdrew halfway through the testing, one male was not eligible after completing the health- screening questionnaire and one female was assigned to an incorrect condition. In Experiment 1 there were 24 participants, of whom 12 were males and 12 were females, aged from 60 to 74 years. The average age was 65.8 years with a standard deviation of 4.2 years. Twelve participants were assigned to the pre-estimate group and twelve were assigned to the post-estimate group. There were also 24 participants in Experiment 2, of whom 12 were females and 12 were males. Again all participants were aged from 60 to 74 years. The average age was 66.7 years with a standard deviation of 4.4 years. Twelve participants were assigned to the pre-estimate group and twelve were assigned to the post-estimate group.

Materials

Stimuli

The basic stimuli were words, which were embedded in sentences. In Experiment 1, there were six distinct sets of phonologically similar words and six distinct sets of phonologically dissimilar words. In Experiment 2, there were six distinct sets of longer words of two syllables and six distinct sets of short words. As can be seen from Appendix 2, an example of the phonologically similar words used in Experiment 1 is:- chart, cart, part, dart, art, heart. An example of the phonologically dissimilar words used is:- suit, fuss, cheer, health, grin, bloom. In Experiment 2 an example of the six sets of longer words used is:- contest, garage, hobby, paddock, couple, saucer. An example of the six sets of short words used is:- claws, trick, sale, broom, scout, yacht.

There were six short sentences in each trial, also shown in Appendix 2, each of which contained one of the target words as its final word. There were three false sentences and three true sentences within each set of six sentences. In Experiment 1 an example of a sentence ending with a phonologically similar word is: - A sailor might use a navigation chart. An example ending in a phonological dissimilar word is:- A jacket, waistcoat and trouser make up a suit. In Experiment 2 an example of a sentence ending with a longer word is:- A competition is the same as a contest. An example ending with a short word is:- Cats and dogs both have claws.

The words to be recalled by the participants were at the end of each sentence. There were twelve trials in each experiment and each trial contained six sentences. The sentences were presented in a blue colour in the middle of the computer screen. They were written in lower case with the end word of each sentence in capital letters. The trials were grouped in sets of three according to the type of end word in each set. The order of words was counterbalanced across the group of participants. Half of the participants in Experiment 1 received phonologically similar words on trials 1 to 3 and 7 to 9, and dissimilar words on trials 4 to 6 and 10 to 12. The order of these trials was reversed for the other half of the participants who received dissimilar words on trials 1 to 3 and 7 to 9, and similar words on trials 4 to 6 and 10 to 12. In Experiment 2, half the

participants received one-syllable words on trials 1 to 3 and 7 to 9, and two-syllable words on trials 4 to 6 and 10 to 12. The order of these trials was reversed for the other half of the participants who received two-syllable words on trials 1 to 3 and 7 to 9 and one-syllable words on trials 4 to 6 and 10 to 12.

Response sheets

The response sheets (see Appendix 3) consisted of three A4 sheets. These were designed in table form with boxes for the participants to write their answers for the four practice trials followed by the twelve experimental trials. Instructions about the experiment were included at the top of the first page.

Apparatus

The experiments were presented on a Toshiba T1200 laptop computer. A computer programme was written by Harvey Jones, School of Psychology based on prior experimental work undertaken by Richards-Ward (1996) and Baken (1998). The programme controlled the stimulus presentation, recording of viewing times, and registration of predictions and postdictions.

Memory Functioning Questionnaire

This Memory Functioning Questionnaire is a questionnaire about how people remember information. It was developed by Gilewski, Zelinski and Schaie (1990) to measure General Frequency of Forgetting, Seriousness of Forgetting, Retrospective Functioning, and Mnemonics Usage. As shown in Appendix 4, it was two A4 pages in length and there were no right or wrong answers. There were four sections under the General Frequency of Forgetting questions. Firstly, participants were asked 18 questions which related to whether they had any difficulty remembering everyday information, for example, appointments, names, faces, directions. These questions were ranked on a

scale of 1 to 7 with 1 being 'always', 7 being 'never', 'sometimes' ranked as 3, 4 or 5. The next section had 5 questions, relating to how often people had trouble remembering what they have read, on a scale of 1 to 7, with 1 being 'always' and 7 being 'never.' The following section was similar with 5 questions pertaining to reading a newspaper or magazine article. Then there were four questions asking how well people remembered things that occurred in time, ranked from 1 being 'very bad' to 7 being 'very good' and 3,4,5, being 'fair'. The Seriousness of Forgetting questions were the same 18 items listed under the Frequency of Forgetting section but asked people how serious it would be if they forgot in these situations. This was ranked from 1 being 'very serious' to 7 being 'not serious' and 3,4,5 being 'somewhat serious'. The Retrospective Functioning section asked people five questions in time about their memory now compared to the way it was, ranked from 1 (much worse) to 7 (much better). The final section on Mnemonics usage asked people eight questions about whether they used techniques to remember items. Answers ranged from 1 (always) to 7 (never). The original purpose for developing the MFQ was to create an instrument for the assessment of self-perceptions of memory abilities. Although the MFQ is not a substitute for memory tasks, it is likely to be a useful adjunct to those tasks because it measures how individuals perceive their memory abilities, which may bear to some extent on their performance (Zelinski et al.,1990).

Procedure

In almost all cases the experiment was conducted at the homes of the participants by the researcher. One participant chose to complete the experiment at the home of the researcher. In all homes the computer was set up on a table in a quiet room, away from any distraction, with adequate lighting.

The participants were given the Information Sheet to re-read so that they would fully understand what would be expected of them and their rights and responsibilities as participants. If they agreed to continue with the experiment they were given a Consent Form to sign which again explained their rights as participants in the experiment. This

was followed by completion of a Health Screening Questionnaire, which ensured the participant was not suffering from any medical problems that would impair memory performance. The Consent Form and Screening Questionnaire are included in Appendices 5 and 6.

The researcher explained the task to the participant and also showed the response sheet, which was to be used to write down the correct words in correct order as presented on the computer screen. The computer programme initially asked for some basic demographic information: name, participant identification number, age, and gender. The researcher explained the basic keyboard functions that were to be used in the experiment and guided the participant through the initial series of computer screens which gave step by step instructions of the task required for the experiment. The computer allowed for unlimited viewing of instructions so that the participant only continued onto the next stage when feeling completely comfortable about the task. This was also an opportunity for familiarisation with the operation of the computer for those who had little computer exposure.

There were four practice trials before the main experiment; these consisted of two trials of each word type that would be encountered in the trials for the experiment. This enabled the participant to gain a further understanding of the task. No feedback was given to the participant on their practice trial performance. When it was clear that they understood the task they were left alone to complete the experiment.

Prior to completing the computer task, half of the participants in Experiment 1 were chosen to give predictions for all trials and half were chosen to give postdictions. The same procedure was followed with Experiment 2.

Before each trial the participants were advised on the computer screen the type of words they would encounter. The people chosen to give predictions were also instructed on the computer to enter a pre-estimate (from 0 to 6) of how many words they thought they would recall in the correct order. Those people chosen for postdictions were instructed by the computer to enter a post-estimate (from 0 to 6) of how many words they thought they had recalled in the correct position.

Each trial involved the presentation of 6 true/false sentences. After each sentence was presented, participants had to decide whether it was true or false, and to indicate their decision by pressing the T or F key. This requirement was to insure that participants processed the full sentences for meaning, rather than merely focusing on their final words. When the participants pressed the T or F key, the response accuracy and response time were recorded, and then the next sentence was presented. If the participants did not press the T or F key within 20 seconds the computer continued on with the next sentence and recorded a nil score for the sentence missed. After the participants had viewed the 6 sentences, an instruction screen appeared and the participants were instructed to write down as many words as they could remember in the correct serial position on the response sheet. People who were chosen to give postdictions were instructed by the computer to enter a post-estimate (from 0 to 6) of how many words they thought they had recalled in the correct position. After 20 seconds, the computer emitted a beep, which informed the participant that the recall period had ended, to stop writing and begin the next trial. Participants who had two-syllable words were instructed to write down the first four letters only of each word, as it would take too long to write the whole word.

After completing the experiment on the computer the researcher asked the participant for feedback about their experience and the strategies used in the task. In particular, participants were asked whether they had any difficulty using the computer, and if they felt this had impacted on the difficulty of the task. They were also asked whether they found rhyming words easier to remember than non-rhyming words (Experiment 1) or longer words harder than short words (Experiment 2). In addition they were asked how they had tried to remember the words and whether they thought they would have been better completing the task at another time of the day. Answers to these questions were recorded by the experimenter as separate notes, with the participant's identification number, to be utilised when discussing the findings of the experiments.

The participant was then asked to complete the Memory Functioning Questionnaire, which required about ten minutes. The researcher gave the participant a further information sheet at completion of the session, which explained how the data collected

were to be used, the role of metamemory in the experiment and thanked them for their participation (see Appendix 7). Participants were also given the opportunity to indicate whether they wished to receive a summary of the findings after the data were analysed and this was sent to those who indicated interest (see Appendix 8).

RESULTS

Scoring

For each participant there were two recall measures, recall in correct position and recall in any position, and one metamemory measure, either mean prediction or mean postdiction. The recall measures were scored manually from the response sheets, with scores averaged across the six trials for each word type. Each measure was the mean number of words.

There were also two sentence measures, verification time and verification accuracy. Verification time was measured in milliseconds, and verification accuracy was expressed as a percentage. These were measured separately for true and false sentences, and averaged across the six trials for each word type. The Memory Functioning Questionnaire score was calculated by manually adding the scores from each section to obtain a total score for each participant.

Experiment 1 measured recall accuracy of words in any position, recall accuracy of words in correct position, predictions and postdictions, for similar and dissimilar words. The verification times to sentences and verification accuracy of sentences were measured separately for true and false sentences. The scoring and analysis for Experiment 2 was parallel to that conducted in Experiment 1 except for the fact that the words used in Experiment 2 were short and long words rather than similar and dissimilar.

Overview

The analysis of the data from this study is presented in four sections. The first section examines the data from Experiment 1, involving phonologically similar and dissimilar words. The second section reports parallel analyses for the Experiment 2 data, involving

long and short words. The Memory Functioning Questionnaire scores are discussed in the third section. In the last section the data from Experiment 1 and 2 are compared to results reported by Richards-Ward (1996), for a young adult sample who completed the same complex-span task.

Experiment 1

Sentence Verification Task

First the participants' performance in the sentence verification task will be considered. This will be followed by the results of participants' performance in the word recall task.

Table 1 shows verification time and accuracy in Experiment 1 as a function of word type (similar or dissimilar) and sentence value (true or false).

As can be seen from Table 1, the participants spent longer verifying the sentences with dissimilar sounding words than with similar sounding words, and longer verifying true sentences than false sentences. The main effect of word type was significant, $F(1, 22) = 10.93$, $p < .001$, as was the main effect of sentence, $F(1, 22) = 7.662$, $p < .001$.

Participants were more accurate for dissimilar sentences (96%) than for similar sentences (93%); this difference was not significant, $F(1, 22) = 2.672$, $p = .116$. True sentences were more accurate (96%) than false sentences (93%), $F(1, 22) = 11.478$, $p < .001$. This was significant.

Table 1.

Mean verification times and mean accuracy for True and False sentences as a function of word type in Experiment 1. Standard deviations are shown in parentheses.

Measure	Word Type		
	Similar	Dissimilar	Mean
Verification Time			
True	4697 (1039)	5006 (885)	4851 (962)
False	4559 (954)	4730 (767)	4644 (860)
Mean	4628 (996)	4868 (826)	4747 (911)
Accuracy			
True	95 (8.21)	97 (5.42)	96 (6.82)
False	91 (8.62)	94 (9.65)	93 (9.13)
Mean	93 (8.41)	96 (7.53)	94 (7.97)

Note: Verification time values are milliseconds, accuracy values are percentages.

Word Recall

Table 2 shows performance in the word recall task as a function of word type, and time of estimate. For the first analysis, words recalled in any position were analysed as a function of time of estimate (pre or post) and word type (similar or dissimilar). Recall in any position showed a main effect of word type. Phonologically similar words were recalled significantly better than dissimilar words, $F(1,22) = 23.99$, $p < .001$. There were no significant differences between predictors and postdictors, $F < 1$ for recall in any position. There was no interaction between word type and test time, $F < 1$.

Table 2.

Mean for Recall Accuracy as a function of word type and time of estimate in Experiment

1. Standard deviations are shown in parentheses.

Measure	Word Type		
	Similar	Dissimilar	Mean
Recall in any position			
Predictors	3.53 (0.99)	2.76 (0.69)	3.14 (0.84)
Postdictors	3.80 (1.29)	3.17 (1.06)	3.48 (1.17)
Mean	3.67 (1.14)	2.96 (0.87)	3.31 (1.00)
Recall in correct position			
Predictors	2.11 (0.94)	2.01 (0.74)	2.06 (0.84)
Postdictors	2.74 (0.91)	2.31 (0.93)	2.53 (0.92)
Mean	2.43 (0.96)	2.16 (0.84)	2.30 (0.90)

Note: All measures are number of words per trial. Maximum possible score is 6.00.

Words recalled in the correct position were also analysed as a function of test time (pre or post) and word type (similar or dissimilar). Again, phonologically similar words were recalled significantly better than dissimilar words, $F(1,22) = 8.58$, $p = .008$. There was no significant difference between predictors and postdictors, $F(1,22) = 3.41$, $p = .080$, for recall in correct position. There was no interaction between similar/dissimilar words and test time, $F(1,22) = 1.688$, $p = .209$.

Predictions and Postdictions

Table 3 shows predicted, actual, and postdicted recall as a function of phonological similarity in Experiment 1. The actual recall measure is recall in correct position.

Table 3.

Mean for predicted, actual, and postdicted recall as a function of word type in Experiment 1. Standard deviations are shown in parentheses.

	Similar	Dissimilar	Mean
Predicted Recall	2.45 (0.58)	2.28 (0.75)	2.36 (0.66)
Actual Recall	2.43 (0.96)	2.16 (0.84)	2.30 (0.90)
Postdicted Recall	3.67 (1.18)	3.00 (1.05)	3.34 (1.11)

It can be seen from Table 3 that for similar and dissimilar sounding words the predictions were almost equal to the actual recall: participants overestimated their recall by .02 words, whereas for the dissimilar words recall was overestimated by .12 words. Predictions did not show a main effect of word type, $F(1,22) = 3.07$, $p = .110$.

Postdictions were higher for similar and dissimilar words than predictions. Participants overestimated their recall of similar sounding words by 1.24 words and overestimated their recall of dissimilar sounding words by .84 words. Postdictions showed a main effect of word type, $F(1,22) = 18.89$, $p < .001$, with larger postdictions for similar words.

Experiment 2

Sentence Verification Task

Performance in the sentence verification task will be considered, followed by the results of participants' performance in the word recall task.

Table 4 shows verification time and accuracy in Experiment 2 for True and False sentences as a function of word type (long or short).

As can be seen from Table 4, people spent longer verifying the sentences containing long words (5028 milliseconds) compared to short words (4678 milliseconds), and longer verifying false sentences (4912 milliseconds) than true sentences (4794 milliseconds). The effect of word type on verifying time was significant, $F(1,22) = 12.575$, $p < .001$, but the effect of sentence type was not, $F(1,22) = 1.147$, $p = .298$.

Participants were slightly more accurate on sentences with short words (97%) compared to sentences with long words (93%), but the difference was not significant, $F(1,22) = 2.667$, $p = .105$. There was no difference in verification accuracy as a function of sentence type, $F < 1$.

Table 4.

Mean verification times and mean accuracy for True and False sentences as a function of word type in Experiment 2. Standard deviations are shown in parentheses.

Measure	Word Type		Mean
	Long	Short	
Verification Time			
True	5022 (814)	4567 (794)	4794 (804)
False	5035 (933)	4790 (1084)	4912 (1008)
Mean	5028 (873)	4678 (939)	4853 (906)
Accuracy			
True	92 (6.14)	97 (4.71)	95 (5.42)
False	93 (7.26)	96 (5.92)	95 (6.59)
Mean	93 (6.70)	97 (5.31)	95 (6.00)

Note: Verification time values are milliseconds, accuracy values are percentages.

Word Recall

Table 5 shows performance in the word recall task, as a function of word type and time of estimate.

For the first analysis, words recalled in any position were analysed as a function of time of estimate (pre or post) and word type (long or short). Recall in any position showed a main effect of word type. Short words were recalled significantly better than long words, $F(1,22) = 14.82$, $p < .001$. There were no significant differences between predictors and postdictors, $F(1,22) = 2.14$, $p = .174$, for recall in any position. There was no interaction between word type and test time, $F(1,22) = 1.935$, $p = .180$.

Table 5.

Mean for Recall Accuracy as a function of word type and time of estimate in Experiment 2.

Standard deviations are shown in parentheses.

	Word Type		
Measure	Long	Short	Mean
Recall in any position			
Predictors	3.37 (1.13)	3.91 (1.17)	3.64 (1.15)
Postdictors	2.88 (1.07)	3.19 (1.04)	3.03 (1.05)
Mean	3.12 (1.10)	3.55 (1.10)	3.33 (1.10)
Recall in correct position			
Predictors	2.91 (1.29)	3.26 (1.38)	3.08 (1.33)
Postdictors	2.37 (1.18)	2.84 (1.09)	2.60 (1.13)
Mean	2.64 (1.23)	3.05 (1.23)	2.84 (1.23)

Note: All measures are number of words per trial. Maximum possible score is 6.00.

Words recalled in the correct position were also analysed as a function of time of estimate (pre or post) and word type (long or short). Short words were recalled significantly better than long words, $F(1,22) = 8.36$, $p < .001$. There was no significant difference between predictors and postdictors, $F < 1$, for recall in correct position. There was no interaction between long/ short words and test time, $F(1,22) = 1.044$, $p = .319$.

Predictions and Postdictions

Table 6 shows predicted, actual, and postdicted recall as a function of word length in Experiment 2. Actual recall is recall in correct position.

Table 6.

Mean for predicted, actual, and postdicted recall as a function of word type in Experiment 2. Standard deviations are shown in parentheses.

	Long	Short	Mean
Predicted Recall	3.14 (0.61)	3.02 (0.65)	3.08 (0.63)
Actual Recall	2.64 (1.23)	3.05 (1.23)	2.84 (1.23)
Postdicted Recall	2.56 (1.13)	2.26 (1.09)	2.41 (1.11)

It can be seen from Table 6 that for long words the participants overestimated their recall by 0.50 words, whereas for the short words predictions were almost equal to the actual recall, slightly underestimated by .03 words. Predictions did not show a main effect of word type, $F(1,22) = 2.14$, $p = .17$.

Postdictions were lower for long and short words than predictions. Participants underestimated their recall of longer words by .08 words and underestimated their recall of short words by 0.79 words. Postdictions did not show a main effect of word type, $F(1,22) = 1.67$, $p = .23$.

Memory Functioning Questionnaire Results

The MFQ scores for Experiment 1 ranged from a minimum of 204 to a maximum of 347 with a mean of 281 (sd =39.04). MFQ scores for Experiment 2 ranged from a minimum of 231 to a maximum of 339, with a mean of 295 (sd =25.78).

The MFQ scores were correlated with recall accuracy. Overall recall accuracy, for each person, both in any position and also in correct position was calculated by averaging across the two word types. The MFQ scores were correlated with recall accuracy separately for Experiment 1 and Experiment 2.

The partial MFQ scores were calculated by combining scores from the sections dealing with 'General Frequency of Forgetting' and 'Retrospective Functioning'. Scores from the 'Seriousness of Forgetting' and 'Mnemonics Usage' were omitted for these partial MFQ scores. These partial MFQ scores for Experiment 1 ranged from a minimum of 130 to a maximum of 247 with a mean of 191 (sd =24.97). The partial MFQ scores for Experiment 2 ranged from a minimum of 155 to a maximum of 224 with a mean of 193 (sd = 16.13). Again these partial MFQ scores were correlated with recall accuracy separately for Experiment 1 and Experiment 2.

Table 7.

Pearson correlation between MFQ scores and recall accuracy measures.

	Recall correct Expt 1	Recall any Expt 1	Recall correct Expt 2	Recall any Expt 2
Measure				
Full MFQ	.114	.156	.236	.260
Partial MFQ	.349	.216	.252	.274

As shown in Table 7, the full MFQ scores and the partial MFQ scores were not significantly correlated with recall accuracy in either Experiment. The correlations were larger using the partial MFQ scores for both Experiments; the difference is greater in Experiment 1.

Age Effects - A Comparison of Results

To examine the effect of age, data from Experiment 1 and 2 were compared with data from a sample of younger adults (N=21), who completed the same task (Richards-Ward, 1996).

Table 8.

Experiment 1- Means for verification times of true/false sentences and recall accuracy for older and younger adults. Standard deviations are shown in parentheses.

Measure	Age Group	
	Older	Younger
Verification Times		
Similar	4628 (996)	3073 (1057)
Dissimilar	4868 (826)	2878 (904)
Overall	4747 (911)	2975 (980)
Recall in any position		
Similar	3.67 (1.14)	5.28 (0.48)
Dissimilar	2.96 (0.87)	4.32 (0.89)
Overall	3.31 (1.00)	4.80 (0.68)
Recall in correct position		
Similar	2.43 (0.96)	4.21 (1.00)
Dissimilar	2.16 (0.84)	3.83 (1.23)
Overall	2.30 (0.90)	4.01 (1.11)

Note: Verification times are milliseconds; recall values are mean number of words.

Table 8 shows data for older adults (present study) and younger adults (from Richards-Ward (1996)). On all recall measures and time taken to perform the task, the younger adults performed better than the older adults. The older adults overall took longer to verify sentences (4747 milliseconds) than the younger adults (2975 milliseconds). Younger adults showed better recall than older adults, both for recall in any position (4.80 vs. 3.31) and for recall in correct position (4.01 vs. 2.30) Both age groups showed better recall for similar words than for dissimilar words.

Table 9.

Experiment 2- Means for verification times and recall accuracy of true/false sentences for older and younger adults. Standard deviations are shown in parentheses.

Measure	Age Group	
	Older	Younger
Verification times		
Long	5028 (873)	2987 (952)
Short	4678 (939)	2606 (974)
Overall	4853 (906)	2796 (963)
Recall in any position		
Long	3.12 (1.10)	4.53 (0.90)
Short	3.55 (1.10)	4.66 (0.86)
Overall	3.34 (1.12)	4.59 (0.88)
Recall in correct position		
Long	2.64 (1.23)	3.90 (1.11)
Short	3.05 (1.23)	4.10 (1.19)
Overall	2.84 (1.23)	4.00 (1.15)

Note: Verification time values are milliseconds, recall values are mean number of words.

Table 9 contrasts data from older adults (the present Experiment 2) with parallel data for younger adults (from Richards-Ward (1996)). Again, both on recall measures and verification times, the younger adults performed better on the task than the older adults. Overall the older adults took longer to verify the sentences (4853 milliseconds) than the younger adults (2796 milliseconds). Both groups took longer to verify sentences when the final words were long than when they were short. Younger adults showed better recall than older adults, both for recall in any position (4.59 vs. 3.34) and for recall in correct position (4.00 vs. 2.84). Both groups recalled more short than long words, showing a word-length effect.

DISCUSSION

The purpose of the present study was to examine metamemory for working memory in older adults by comparing predicted and postdicted recall with actual performance in the complex span task. After discussing actual recall in the working memory task, on-line metamemory in Experiments 1 and 2 is considered. Then Metamemory Functioning Questionnaire scores are compared to recall accuracy. The discussion then compares results from the complex task to those generated by younger adults in a parallel task. Finally it is appropriate that the discussion considers the limitations of the study and some possible directions for future research.

Working Memory Performance

Experiment 1

Experiment 1 examined whether the phonological similarity effect could be replicated in a complex task. As described previously, the phonological similarity effect is when fewer words that sound similar are recalled in the correct serial position than words that are phonologically dissimilar (Baddeley, 1966a; Conrad & Hull, 1964; Kintsch & Bushke, 1969). Contrary to expectations there was no phonological similarity effect. In fact participants recalled more phonologically similar than dissimilar words. However, parallel results were also found by Richards-Ward (1996), in a younger group completing the same task.

It is important to consider why people recalled more phonologically similar than dissimilar words. After people completed the trials they were asked by the experimenter whether they had used any strategies to remember the words and which words they had found easier to remember. Most people explained that they had used an accumulated rehearsal technique to remember the words. A few people recited them prior to reading the True/False sentences adding each new word to the list to recite, whereas others recited the words at the end of each sentence as they were reading them. They found it easier to recite the rhyming words although got muddled with the correct order of the

words. Data from the present study show the advantage for similar words is twice as large (.70 words) for recall in any order than when correct order is required (.27 words). This supports the hypothesis proposed by Wickelgren (1965, cited in Baddeley, 1968), who points out that "acoustic similarity leads to poorer performance, because of failure to reproduce items in the correct order, not because the items themselves are less available, indeed recall of the items irrespective of order may be better for acoustically similar material" (p.258). Alternatively, people may have guessed some of the rhyming words. For example, they may have remembered the first word as being 'farm' and then filled in missing words ending in '-arm'. This would have been impossible to do with the non- rhyming words, and may provide some explanation for the better result found with the phonologically similar words.

In Experiment 1, processing time was the time spent viewing and verifying each stimulus. There were no significant differences in the processing time of phonologically similar or dissimilar words. This is important because it shows that the poorer recall for dissimilar words is not due to less time spent processing the sentences in which they appeared. This finding is consistent with the research of Richards-Ward (1996) who found the same result with younger adults and also Baken (1998) who found the same results with older adults completing a simple task. The predictions and postdictions of participants showed they expected to do better with the similar words so they were aware of their memory ability with each word type. It is possible that they did not consider they would improve their performance with the dissimilar words by spending more time on them.

There were also no significant differences in verifying the True/False sentences for similar/dissimilar words. This shows that the accuracy of the True/False sentences was not compromised in order to obtain a better result in recalling the similar words.

Experiment 2

Experiment 2 represented a parallel study to Experiment 1 but where Experiment 1 investigated the phonological similarity effect, Experiment 2 investigated the word-length effect in a complex task. As described previously, the word-length effect observes that it will be harder to remember words of longer spoken duration compared to short words as long words take longer to rehearse than short words, assuming that the rehearsal rate is constant (Baddeley, Thomson & Buchanan, 1975). Because it takes longer to rehearse a long than a short word, more long than short words have been assumed to decay below a recall threshold before they can be rehearsed. Consequently fewer long than short words are likely to be recalled in serial order (Baddeley et al., 1975). As hypothesised, a word-length effect was found; people were better at recalling the shorter one-syllable words than the longer two-syllable words, both in any order (short words were 0.43 words better) and in correct order (short words were 0.41 words better). As less long words than short words can be rehearsed in a given period of time it was easier for people to remember the short words. Again participants explained, after the experiment, that they had used an accumulated rehearsal technique to remember the words. This supports results found by Baddeley, Thomson and Buchanan (1975), who suggested the word-length effect is the result of the limited capacity of the rehearsal loop. Again there were more words recalled in any order than words recalled in correct order. Hence memory span is smaller for items taking longer to pronounce (Baddeley, Thomson, & Buchanan, 1975; Mackworth, 1963, Schweickert & Boruff, 1986 cited in Schweickert, Guentert & Hersberger, 1990).

As in Experiment 1, processing time in Experiment 2 was the time spent viewing and verifying each stimulus. Again there were no significant differences in the processing time of long or short words. This is important because it shows that the poorer recall for longer words is not due to less time processing the sentences in which they appeared.

There were also no significant differences in verifying the True/False sentences for long/short words. This shows that the accuracy of the True/False sentences was not compromised in order to obtain a better result in recalling the short words. These findings are consistent with the research of Richards-Ward (1996) who found the same result with younger adults.

Metamemory for Working Memory

Predictions and Postdictions

Peoples' ability to monitor the operation of their own working memory was also examined. In Experiment 1 people were accurate in reporting that they recalled more similar than dissimilar words, both with their predictions and postdictions. Unexpectedly, their predictions were slightly more accurate than their postdictions. This indicates that their estimations showed some level of accuracy and there was some degree of metamemory because to do this people would need to be aware of their performance. People are able to generally predict their recall (e.g. Bruce et al., 1982; Devolder et al., 1990; Hultsch, Hertzog, Dixon, & Davidson, 1988; Lovelace, 1984).

However, in Experiment 1 peoples' postdictions overestimated their actual recall by 1.24 words for similar words and 0.84 words for dissimilar words. This is consistent with other research in which older adults overestimated their memory performance. For example, Lovelace and Marsh (1985, cited in Matlin, 1994) asked elderly people (whose average age was 67) to study 60 pairs of unrelated English words and then rate their likelihood of recalling each item later. Estimates were compared with the number of pairs each person recalled correctly. It was found that the elderly adults estimated that they would recall 14 items more than they actually did recall. Several other studies have suggested that older people overestimate their performance on cognitive tasks, although not necessarily in all conditions (Coyne, 1985; Lachman & Jelalian, 1984; Murphy et. al., 1981).

In Experiment 2 people unexpectedly predicted and postdicted that they would do slightly better with long than short words. It is possible that they decided they made more effort to remember the longer words or they felt they were spending more time viewing the longer words. The predictions for long words were overestimated. As discussed previously in the metamemory section Bruce et al. (1982) and Murphy et al. (1981) also found that older adults typically predict that they will be able to remember more items than they actually do. However, predictions for short words and postdictions for long and short words were underestimated. This is interesting as Camp, Markley,

and Kramer (1983) also found older adults tended to underestimate their abilities when predicting success at remembering 15 words, especially if they were asked to think about strategies they might use to improve their memory performance. Brigham and Pressley (1988) and Hanley-Dunn and McIntosh (1984) also found that older adults underestimated their performance on key-word-item tasks when asked for their postdictions.

Hertzog, Dixon and Hultsch (1990) suggest that peoples' beliefs and efficacy judgements have important implications for explaining prediction behavior as well as prediction accuracy. They suggest that inaccurate performance predictions may be a result of inaccurate self-efficacy, either global or local. The belief system must be combined with the task appraisal to produce an estimate of performance. If the task is not familiar then it will be difficult to make an accurate estimate of performance ability. Older persons may overestimate their memory capacity or they may underestimate the task difficulty. The comments made to the experimenter, by most of the participants, during the period prior to the presentation, belie the first of these; rather than seeming very confident of their memory abilities in general, most of the older persons made comments indicating that their memory was poor or not as good as it used to be. This implies that overestimation may be due to lack of appropriate recent experiences on similar tasks. Although no systematic questionnaire was administered, at the end of the experimental session many older participants observed that they found the task much harder than they expected.

The way that prediction and postdiction accuracy is measured in this research may also explain inconsistencies found in Experiments 1 and 2. Some people explained to the experimenter, after completing the task, they had not bothered to change their predictions or postdictions (depending which group they were in), from trial to trial, as they felt they would obtain much the same results rather than improve with practice. Some also explained that they found it difficult to choose a number between 1-6 in the time allotted, and rather than having to make a definite choice, chose a number about the middle of the range as a safe choice.

MFQ Scores

There was no correlation between the MFQ scores and the recall accuracy in either Experiment 1 or Experiment 2. It was hypothesized that those people scoring higher on the MFQ would also score high on the recall task. Other studies (for example, Larrabee & Levin, 1986; Zelinski, Gilewski & Anthony-Bergstone, 1990) have found that self-perception of memory has a modest correlation with performance on memory tasks in some studies. In these studies after the effects of depression, education, and health were partialled out the MFQ scores predicted performance on list memory tasks. The mean score for their normative sample of 590 adults aged 50-89 was 283 which compares to the MFQ mean scores obtained in the present study of 281 in Experiment 1 and 295 in Experiment 2. In these studies the memory task was a simple recall task. It is possible that results differ on a complex task as was the case in this study.

The study of memory in the laboratory has always been open to the objection that it may say little about memory as it operates in everyday life. Questioning people about their memory is not identical to actually testing the accuracy of this knowledge. The MFQ has questions to tap people's knowledge of their own memory ability on more general aspects of everyday memory, whereas the recall task involved a single and very specific aspect of memory. Sunderland et al. (1986) suggested that self-reported memory failures might be more representative of the kinds of problems reported by individuals with memory complaints than are laboratory or clinical tests. It is conceivable that memory tests in general are not sensitive to the kinds of memory problems older people experience in everyday contexts (Erickson & Howieson, 1986). There is also the fact that older people may use mnemonics, such as reminder lists for appointments and shopping in everyday life whereas the computer task was a recall task of their memory ability.

It was considered that the MFQ questions that asked participants how serious a problem they considered their forgetfulness and also mnemonics usage, were not measuring memory performance as such. When these questions were omitted from the data analysis the correlation between the new MFQ scores and memory recall task was higher.

It seems highly probable that the proximal cause of self-reported frequency of forgetting is not true frequency of forgetting but, rather, memory self-efficacy beliefs. A more plausible representation of frequency report behavior is that individuals access beliefs about their memory self-efficacy and then convert these beliefs into a frequency estimate. Another possibility is that, regardless of item content, older individuals are loath to use extremes of frequency rating scales. This was found in the computer recall task when participants assessed the number of words they had recalled in correct order and reported that they had sometimes made a safe choice by using a median score.

Alternatively it may simply be the case that people, especially older ones, cannot objectively gauge their own memory ability. For example, Cavanaugh, Grady and Perlmutter (1983) have suggested that older people may be influenced by general cultural expectations that aging is a cause of memory failures and thus may be insensitive to the nature of their memory problems.

A contributing factor may be memory loss (i.e. forgetting), a situation that has been referred to as the memory introspection paradox- the paradox holds that the poorer one's memory aptitude, the more difficult it will be to remember what one's memory is really like. Some participants may have also felt under stress during completion of the computer task. The MFQ responses were completed after the computer task and this may have affected the way in which participants answered questions about their everyday memory. Questionnaire responses have been found to correlate with susceptibility to cognitive failure under stress (Broadbent et al., 1982).

There have been several recommendations in the clinical literature that significant others might be more reliable sources of information on the everyday memory functioning of cognitively impaired older subjects than the subjects themselves (for example, Jorm & Korten, 1988). Whether this would be true for the unimpaired elderly is not entirely clear, however, because Sunderland et al., (1986) found no relationship between spouse measures and performance on memory tasks in normal elders. Further studies involving larger samples and comparing ratings of individuals with and without significant others participating would be helpful.

Age Comparison

In comparing the two age groups, it was hypothesized that the older adults would not remember as many words as the younger adults would. As discussed in the introduction, it was expected that older people would find the requirements of a complex task more difficult than younger people, as age differences generally increase with processing complexity or the number of cognitive operations required. This hypothesis was supported as in both Experiments 1 and 2 the older adults recalled fewer words than the young adults. Across all word types the older adults recalled in any position about 1.36 fewer words than did the young adults, a deficit of approximately 22%. The necessity to manipulate information held in short-term memory while carrying out further operations on the stored items is the hallmark of "working memory" as described by Baddeley and Hitch (1974). This experiment shows a substantial age-related decrement in working memory performance and confirms the results of other studies (Light & Anderson, 1985; Morris et. al. 1988, Spilich, 1983, Wright, 1981, cited in Gick, Craik & Morris, 1988). The age differences in favour of younger adults on the task are consistent with the well-established fact that older adults perform at a lower level on most memory tasks (Craik, 1977).

It was also expected that the older age group would take longer to perform the task. It is well established that increased age is often associated with lower levels of processing efficiency, as reflected by slower responses, in many cognitive tasks (Salthouse, 1985). Over the two experiments the older adults took 3829 milliseconds longer to verify sentences than the younger age group. It is difficult to assess how much time was spent verifying and how much of that time was spent rehearsing, as these were not measured separately. Also, the older age group may have taken longer to read the sentences and comprehend them. Murphy et al. (1981) also found, when comparing the study times between younger and older people, that older adults take more time to learn words for recall.

Limitations of the Present Study

There are a number of potential methodological problems with the present study. First the age groups were not matched for educational attainment, or vocabulary ability. Educational attainment is a demographic variable often cited as confounded with age in adult developmental research (for example, Poon, Krauss & Bowles, 1984). However, other researchers have suggested that there is a lack of relationship between education and memory monitoring (Murphy, Schmitt, Caruso, & Sanders, 1987). Therefore not matching for education does not appear to be a major problem in this study. The words used in the present study are very common so it is felt that differences in vocabulary should not have a major effect. There is also the fact that people from birth cohorts 50 years apart differ on many variables, including education. For example, even if years of education are held constant, changes in the quality of that education could produce age differences. In principle, adequate control of all these variables can never be completely achieved. Additionally, these groups undoubtedly also differed with respect to intelligence, although people chose to volunteer and it is likely that people would volunteer if they felt capable of performing the memory task so the effects of intelligence may have been diluted. It is also conceivable that individuals at highest risk for poor performance, and with lowest prior self-efficacy beliefs, are much less likely to volunteer for memory experiments.

It is possible that age-related differences in metamemory are more likely in laboratory than naturalistic tasks. Laboratory memory performance has been shown to be highly related to formal education (Sharp et al., 1979). Since older adults have had on the average less education, longer ago, than young adults, it would not be surprising if performance on laboratory tasks might suffer more than performance on metamemory tasks closer to real life situations. Laboratory studies of memory have focused on the individual's use of internal memory aids (organization, mnemonics, and depth of processing). However in real-life memory tasks, people often use external memory aids such as lists, appointments, schedules, and timers. Questionnaire studies reported older adults may rely more on external memory aids, while younger adults use more internally based mnemonics (Cavanaugh & Poon, 1989).

The worse performance of older participants may be the result of their greater susceptibility to anxiety produced by strange situations such as the laboratory milieu, and their anxiety may be further compounded by the use of the computer. Some of the older participants had not used a computer before, which caused a lack of confidence for those participants. Some explained to the experimenter that they were spending more concentration on using the computer than completing the task. Older adults may be less tolerant of unfamiliar learning tasks. Devolder and Pressley (1989) suggest that older adults are more likely than younger adults to experience anxiety and negative arousal when memory difficulties occur.

Although this study was a partial replication of the research of Richards-Ward (1996), and the hypothesis that older adults would not recall as many words as the younger adults was confirmed, there are several issues that arise when comparing the results from the two studies. The experiments were conducted by two different experimenters. Therefore it is possible that results may have been affected by different ways that the experimenters explained the task to the participants. Also, location and time of day may have affected results. In this study, all participants, except one, were interviewed in their own homes whereas the experiment by Richards-Ward (1996) was conducted in the cognitive laboratory at Massey University's School of Psychology. There might have been different distractions in these diverse locations. However, research conducted by Devolder et al. (1990) in peoples' homes and a university laboratory found the results did not differ with dissimilar locations.

As previously noted, metamemory is a term that has been applied to any of several varieties of memory monitoring tasks. As Cavanaugh and Perlmutter (1982) recently observed, there is a great deal of variability in what is meant by the term metamemory. It should be kept in mind that metamemory is not a single element of knowledge that older adults have or don't have. It is a complex constellation of facts about capacity, tasks, strategies, and their interactions (Cavanaugh & Perlmutter, 1982; Dixon & Hultsch, 1983; Flavell & Wellman, 1977). It also involves knowledge about the current state of the memory system that can be gained only concurrently with task performance. The processes tapped by a metamemory decision may differ with regard to whether or not access to conscious awareness is required, or whether they access ongoing memory

processes or are general overall ratings not tied to current processing. Predictions based on items remembered monitor ongoing memory processes rather than beliefs about relative memory performance across tasks. Devolder et al. (1990) suggest it is worth stressing the distinction between predicting performance on an item-by-item basis, as in the present experiment, and prediction of overall performance.

Future Research

Memory monitoring in adulthood has been the object of study more often than has memory knowledge, the other type of metamemory. The focus of metamemory research across the adult lifespan should broaden in the future. Previous research has concentrated on whether memory declines as people age and the reasons. There is currently little systematic information about what knowledge about memory adults bring to bear in memory tasks. As can be seen from the present study there is much more than awareness of past and future performance levels that people can know about memory, with many different types of information potentially affecting memory performance. An accurate portrayal of memory and metamemory in the aged will require investigations over a broad range of tasks and situations. Decline in memory could be due to a number of shifts in metamemory and interaction of metamemory with other factors.

It may be helpful to conduct questionnaires and tests dealing with real-life situations and compare them to laboratory studies. Perlmutter (1978) has suggested that there are limitations in the generalizability of findings from typical laboratory tasks. It may well be that individuals can very accurately report their actual levels of competence in particular everyday situations but that their insights are situation specific. People's knowledge of their competence in particular familiar tasks may thus be of little use to them as a guide to their performance in novel situations.

It has been found from this study that older people were more penalized by the requirements of a heavier memory load than younger people, confirming the results of other studies (Light & Anderson, 1985; Morris et al., 1988, Spilich, 1983, Wright, 1981 cited in Gick, Craik & Morris, 1988). Results suggest that older people have greater difficulty with the ongoing processing aspects of working memory tasks, and thus they are less able to add additional words to the rehearsal loop, especially when complex sentences are presented. It would be interesting to conduct further experiments on different tasks of complexity and compare effects. Devolder et al. (1990) has shown that diverse tasks can provide disparate results in studies showing age-related memory differences. Older adults may prove to be more capable with some complex memory tasks than others and this will be useful in providing further knowledge about memory difficulties. It would be helpful to find out strategies used by older people who have good memories. It may be possible to train the elderly to use memory- enhancing strategies to develop and improve memory.

Conclusion

The present study aimed to assess the metamemory of older adults by using a complex task, based on the working memory span test of Daneman and Carpenter (1980), which required the participant to perform not only word identification and storage operations, but language comprehension processes as well. The complex task was designed to estimate the ability to hold information in memory while simultaneously performing comprehension operations. The participants were also required to assess their own memory ability both during the computer task and by written questionnaire.

Findings indicated that older adults had some accurate on-line metamemory for working memory. Although participants' predictions and postdictions overestimated their results, they were accurate in the fact that they would recall more similar than dissimilar words. This indicated that they were able to estimate their memory performance, using metamemory in a complex memory task. However, they

unexpectedly predicted and postdicted that they would be more accurate with long than short words. The older participants may have been unaware that their memory is declining, or alternatively they may have underestimated the task difficulty.

A comparison between young and older adults confirmed that performance on the recall task and viewing times was better for the younger participants than the older age group indicating that on a complex task there is an age-related deficit.

There was no correlation between the MFQ scores and recall task performance possibly because people were measuring different aspects of their memory.

It is not possible from this study to suggest that age-related differences in recall are due solely to age-related differences in metamemory as there are many possible explanations for the age differences in on-line metamemory. It needs to be kept in mind that the construct of metamemory is complex and multifaceted. It is conceivable that speed, capacity, strategies and metamemory all play roles, differing in importance depending on the task, in producing adult age differences in memory performance.

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Appendix 1-Information Sheet



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RESEARCH PROJECT ON WORKING MEMORY INFORMATION SHEET

I would like to invite you to consider taking part in a research project on working memory.

The person conducting this research is Cheryll Craighead, who currently works at Housing New Zealand as a Tenancy Manager. Cheryll is also a student at Massey University and is doing this research in order to complete a Masters degree in psychology. The research is not connected in any way with her job at Housing New Zealand.

Cheryll is supervised by Dr Julie Bunnell, who is a senior lecturer in psychology at Massey University, Palmerston North. Cheryll Craighead can be contacted at home (in the evenings) on 03 546 4737; Dr Bunnell can be contacted at Massey (during the day) on 06 350 5799 x 2046.

This project involves an experiment investigating how much knowledge older adults have of their short-term memory. You will be asked to complete a memory test on a computer. The test will involve deciding whether sentences, e.g. "A table is the same as a chair", are true or false. There will be six sentences in each trial. You will also be asked to remember the last word of each sentence. Either before each trial or after each trial, you will be asked how well you think you will remember the words, or how well you think you did remember the words.

Before the experiment starts there will be some practice trials on the computer so that you will feel comfortable about what you are expected to do. The experiment will consist of twelve trials in total on the computer. After this you will be asked to fill in a questionnaire about how you remember information. This experiment will take about one and a half hours of your time.



If you choose to take part in this experiment it can be conducted at your home in a quiet room free from distractions. The date and time will be arranged to suit you. Cheryll Craighead will conduct the experiment. Before the experiment, we will need to ask you some questions about certain medical conditions, which are known to affect memory. The experiment will be explained to you and then you will be invited to complete a consent form.

If you choose to take part in the experiment, you have the right to:

Refuse to answer any particular question.

Withdraw from the experiment at any time.

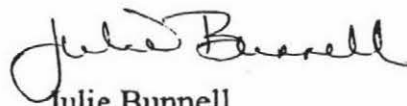
Ask questions about the experiment at any time.

Provide information on the understanding that your name will not be used unless you give permission to the researcher.

Receive a summary of the findings from the experiment when it is completed.

This research project has been considered and approved by the Massey University Human Ethics Committee. Nevertheless, if you have any questions or concerns about the experiment, or you would like further information about the experiment, please contact either of us at the addresses below.

Thank you for taking the time to read this information sheet. **If you think you would like to participate in this research project, please contact Cheryll Craighead by telephoning (03) 5464737. The best time to contact Cheryll is in the evenings or at the weekends.**



Julie Bunnell
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Appendix 2- True/False sentences used

CHART	S T A sailor might use a navigation
CART	S F Cats are traditionally used to pull a
PART	S T Something extra is a spare
DART	S T Paper can be used to make a
ART	S F Jogging is a type of
HEART	S F A person can easily survive without a
HARM	S T To be safe is to be out of
FARM	S T One sees animals on a
CHARM	S F A book is a type of magical
ARM	S T Your hand is at the end of your
CALM	S F Panic is the same as
PALM	S F Oak trees are a type of
BREEZE	S F On a perfectly calm day one might feel a
CHEESE	S F Margarine is a type of
KEYS	S T To open a lock, one might need a set of
KNEES	S T A person's legs bend at the
PEAS	S T Small round green vegetables might be called
SEAS	S F Land-lubbers are often found sailing the high
ACHE	S T A pain in the body is called an
CAKE	S F Gravel is one ingredient of
RAKE	S F Water can be moved with a
STAKE	S T Tomato plants might grow up a
SHAKE	S T In an earthquake, loose objects are likely to
BREAK	S F A join is the same as a
BEAR	S T A large furry animal could be called a
CHAIR	S F A table is the same as a
FAIR	S T Candy-floss and merry-go-rounds are found at a
HAIR	S F A spoon is used to shave off unwanted
SHARE	S T A portion of something is called a
TEAR	S F A rip is different to a
BUG	S F A cat is a type of
RUG	S F One might eat a
MUG	S F One can have a bath in a
JUG	S T A pot that holds milk is called a
LUG	S T Another name for a wheel-nut is a
DRUG	S T Heroin is a dangerous
SUIT	D T A jacket, waistcoat and trouser make up a
FUSS	D T Yelling and screaming can be called making a
CHEER	D F To be very quiet is to
HEALTH	D T Sickness is the opposite of good
TWINS	D F Four children can be called
BLOOM	D F When a flower dies it is said to
JAR	D F Water is never stored in a
GRIN	D T Another name for a smile is a
GROWL	D F The squeak of a mouse is like a lion's
KICK	D T A Kung-fu expert might use a flying
VOTE	D T Politicians are elected by a
SMELL	D F The colour of something is called its
SHADE	D F Sunshine is the same as
SHELL	D F Spiders live in a
TAG	D T A label on something is called a
MATCH	D T A candle can be lit with a
MARK	D F Scratch is the opposite of
THREAD	D T A long thin string could be called a
WORMS	D F Spaghetti is made from dried
EDGE	D T Before falling off a cliff you first come to the
SHEETS	D T Beds are made with blankets and
CAB	D T Another name for a taxi is a
KID	D F Someone who is very old is called a
STRAW	D F Rocks are as soft as
CHEST	D T People's lungs are in their
BUNK	D F People usually eat off a
CLOUDS	D F It never rains when the sky is full of
PATH	D T A track is type of
COMB	D T A tool to arrange hair with is called a
CROWD	D F It is easy to find someone in a
SCENE	D T A view of the countryside can be called a
TRUNKS	D F Giraffes have long
PLAIN	D F Fancy is the same as
VERB	D T All sentences must contain a
STAGE	D T Actors and actresses can act on a
WINGS	D F Cats have

Appendix 2

CLAWS	O T Cats and dogs both have
TRICK	O F An innocent mistake is the same as a deliberate
SALE	O F An increase in prices is called a
BROOM	O T Dust can be swept away with a
SHOUT	O T Cowboys in the movies sometimes have an Indian
YACHT	O F An automobile is a type of
PLATE	O T Food is served on a
SOCKS	O F Elbows are kept warm by
SCOUT	O F A very quiet voice is called a
LIE	O F A truism is the same as a
TRAIL	O T A long walkway can be called a
SPORT	O T Games played for fun can be called
BOOT	O F A sandal is heavier than a work
BRICK	O T Houses can be built in
STEAM	O T Hot water turns into
TUB	O F A lake is smaller than a
TOOLS	O F Good workers always blame their
CHAIN	O T Joined steel rings form a
FINE	O F A person found not-guilty would have to pay a
WEIGHT	O T Kilograms are units of
SPEECH	O F A one word answer could be called a
HUT	O F A mansion is smaller than a
PAD	O T Where a helicopter lands is called a
PUMP	O T Water is moved with a
WAKE	O T A funeral may be accompanied by a
EVE	O T The night before Christmas is called Christmas
LAMP	O F Darkness comes from a
GIFT	O T Something for nothing is a
DIP	O F A hill is the same as a
FOOD	O F A hammer is a type of
JUICE	O T The liquid from an orange is its
WIRE	O T Telephones used to all be connected by
CANE	O F A flag-pole is smaller than a walking
BULL	O F A female cat is called a
PIPE	O T Smokers use cigarettes, cigars, or a
GAP	O F A hairline crack is bigger than a large
CONTEST	T T A competition is the same as
GARAGE	T T A car is usually parked in a
HOBBY	T F Work is always the same as a
PADDOCK	T T A field is the same as a
COUPLE	T F Three people form a
SAUCER	T F The Wright brothers invented the flying
GRANDPA	T T Grandma's husband is usually called
STOMACH	T T Food is digested in the
KINDNESS	T F Nastiness is the same as
LEATHER	T F Milk bottles are made of
FOOTPATH	T F Cars usually drive on the
HEATER	T T A house can be warmed with a
CELLAR	T T Wine can be kept in a
ADDRESS	T T Where someone lives is their home
SUNSET	T F At mid-day one can watch the
CAMEL	T F An elephant is smaller than a
SNOWBALL	T F A green and square object is called a
PADDLE	T T A person rowing a life raft could use a
REWARD	T F Punishment is the same as
REPORT	T T A school teacher might write a
DISTANCE	T F Auckland and Wellington are within easy walking
MARBLE	T T Statues are often made of
AIRPORT	T T Airplanes land at an
CIRCLE	T F A square is more round than a circle
SHOPPING	T T Buying groceries is called
BEAUTY	T T Attractiveness is another word for
PUPIL	T F A teacher is the same as a
TREASURE	T F A bag of worthless stones is called
TIGER	T F A flea is larger than a
UNION	T T A group of workers can form a
SURFACE	T F The bottom of a lake is called the
CANOE	T F An ocean liner is smaller than a
POPCORN	T T A popular movie snack is
NEIGHBOUR	T T A person who lives next door is called a
HAMMER	T T Nails are struck with a
FREEDOM	T F Animals kept in cages have a lot of

Appendix 2

MOAT	S T Around a castle is a
NOTE	S F You use a comb to write a
BOAT	S T Fishermen go to sea in a
COAT	S F Worn on the head is a
TOTE	S T To bet on a horse one goes to a
GOAT	S F A bird is a type of
BITE	S T A mouthful of food is a
KITE	S F A boat is a type of
SIGHT	S T One wears glasses to improve
NIGHT	S F The sky is not dark in the
LIGHT	S F Heavy is another word for
FIGHT	S T Boxers in a ring are in a
TOMB	D T An Egyptian Mummy is found in a
PEN	D F To change TV channels one uses a
BALL	D T Children play in a park with a
SHOE	D T Worn on a foot is a
GOLD	D F Coal is used to make
SUN	D F At night the yellow ball in the sky is the
WATCH	D F Worn on the foot is a
CASE	D T Clothes are packed in a
SEA	D F A car drives on the
GOLF	D T A club is used to play
FLU	D T A type of cold is the
TIME	D F If one is late one is on

Response Sheet for Working Memory Study

ID# _____

In this study of working memory there will be a series of 12 trials. On each trial there will be six sentences shown to you on the computer screen, one sentence at a time, which you decide are true or false. You will also be asked to remember the last word of each sentence in the order that they were shown to you. If you cannot remember the exact order, make a best guess. You will have about 15 seconds to write the words that you remember in the spaces below. Use the first line for Trial 1, the second line for Trial 2, and so on. There will be four practice trials to help you become familiar with the task.

Words recalled in the order presented							
Trial	Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	
Prac 1							
Prac 2							
Prac 3							
Prac 4							

ID# _____

Words recalled in the order presented							
Trial	Word 1	Word 2	Word 3	Word 4	Word 5	Word 6	
1							
2							
3							
4							
5							
6							
7							
8							
9							

ID# _____

Words recalled in the order presented						
Trial	Word 1	Word 2	Word 3	Word 4	Word 5	Word 6
10						
11						
12						

Appendix 4- Memory Functioning Questionnaire

Memory Functioning Questionnaire

This is a questionnaire about how you remember information. There are no right or wrong answers. Circle a number between 1 and 7 that best reflects your judgment about your memory. Think carefully about your responses, and try to be as realistic as possible when you make them. Please answer all questions.

General Frequency of Forgetting

How would you rate your memory in terms of the kinds of problems that you have?

Major Problems

Some Minor Problems

No Problems

1

2

3

4

5

6

7

How often do these present a problem for you?

	<i>Always</i>		<i>Sometimes</i>		<i>Never</i>		
a. Names	1	2	3	4	5	6	7
b. Faces	1	2	3	4	5	6	7
c. Appointments	1	2	3	4	5	6	7
d. Where you put things (eg, Keys)	1	2	3	4	5	6	7
e. Performing household chores	1	2	3	4	5	6	7
f. Directions to places	1	2	3	4	5	6	7
g. Phone numbers you've just checked	1	2	3	4	5	6	7
h. Phone numbers you use frequently	1	2	3	4	5	6	7
i. Things people tell you	1	2	3	4	5	6	7
j. Keeping up correspondence	1	2	3	4	5	6	7
k. Personal dates (eg, birthdays)	1	2	3	4	5	6	7
l. Words	1	2	3	4	5	6	7
m. Going to the store and forgetting what you wanted to buy	1	2	3	4	5	6	7
n. Taking a test	1	2	3	4	5	6	7
o. Beginning to do something and forgetting what you were doing	1	2	3	4	5	6	7
p. Losing the thread of thought in conversation	1	2	3	4	5	6	7
q. Losing the thread of thought in public speaking	1	2	3	4	5	6	7
r. Knowing whether you've already told someone something	1	2	3	4	5	6	7

As you are reading a novel, how often do you have trouble remembering what you have read...

		<i>Always</i>		<i>Sometimes</i>			<i>Never</i>	
a.	In the opening chapters, once you have finished the book	1	2	3	4	5	6	7
b.	Three or four chapters before the one you are currently reading	1	2	3	4	5	6	7
c.	The chapter before the one you are currently reading	1	2	3	4	5	6	7
d.	The paragraph just before the one you are currently reading	1	2	3	4	5	6	7
e.	The sentence before the one you are currently reading	1	2	3	4	5	6	7

When you are reading a paper or magazine article, how often do you have trouble remembering what you have read...

		<i>Always</i>		<i>Sometimes</i>		<i>Never</i>		
a.	In the opening paragraphs, once you have finished the article	1	2	3	4	5	6	7
b.	Three or four paragraphs before the one you are currently reading	1	2	3	4	5	6	7
c.	The paragraph before the one you are currently reading	1	2	3	4	5	6	7
d.	Three or four sentences before the one you are currently reading	1	2	3	4	5	6	7
e.	The sentence before the one you are currently reading	1	2	3	4	5	6	7

Appendix 4

How well you remember things that occurred...

	<i>Very Bad</i>			<i>Fair</i>		<i>Very Good</i>	
a. Last month is	1	2	3	4	5	6	7
b. Between 6 months and 1 year ago is	1	2	3	4	5	6	7
c. Between 1 and 5 years ago is	1	2	3	4	5	6	7
d. Between 6 and 10 years ago is	1	2	3	4	5	6	7

Seriousness or Forgetting

When you actually forget in these situations, how serious of a problem do you consider the memory failure to be?

	<i>Very Serious</i>		<i>Somewhat Serious</i>			<i>Not Serious</i>	
a. Names	1	2	3	4	5	6	7
b. Faces	1	2	3	4	5	6	7
c. Appointments	1	2	3	4	5	6	7
d. Where you put things (eg, keys)	1	2	3	4	5	6	7
e. Performing household chores	1	2	3	4	5	6	7
f. Directions to places	1	2	3	4	5	6	7
g. Phone numbers you've just checked	1	2	3	4	5	6	7
h. Phone numbers used frequently	1	2	3	4	5	6	7
i. Things people tell you	1	2	3	4	5	6	7
j. Keeping up correspondence	1	2	3	4	5	6	7
k. Personal dates (eg, birthdays)	1	2	3	4	5	6	7
l. Words	1	2	3	4	5	6	7
m. Going to the store and forgetting what you wanted to buy	1	2	3	4	5	6	7
n. Taking a test	1	2	3	4	5	6	7
o. Beginning to do something and forgetting what you were doing	1	2	3	4	5	6	7
p. Losing the thread of thought in conversation	1	2	3	4	5	6	7
q. Losing the thread of thought in public speaking	1	2	3	4	5	6	7
r. Knowing whether you've already told someone something	1	2	3	4	5	6	7

Retrospective Functioning

How is your memory compared to the way it was ...

	<i>Much Worse</i>			<i>Same</i>		<i>Much Better</i>	
a. 1 year ago?	1	2	3	4	5	6	7
b. 5 years ago?	1	2	3	4	5	6	7
c. 10 years ago?	1	2	3	4	5	6	7
d. 20 years ago?	1	2	3	4	5	6	7
e. When you were 18?	1	2	3	4	5	6	7

Mnemonics Usage

How often do you use these techniques to remind yourself about things?...

	<i>Always</i>		<i>Sometimes</i>			<i>Never</i>	
a. Keep an appointment book	1	2	3	4	5	6	7
b. Write yourself reminder notes	1	2	3	4	5	6	7
c. Make lists of things to do	1	2	3	4	5	6	7
d. Make grocery lists	1	2	3	4	5	6	7
e. Plan your daily schedule in advance	1	2	3	4	5	6	7
f. Mental repetition	1	2	3	4	5	6	7
g. Association with other things	1	2	3	4	5	6	7
h. Keep things you need to do in a prominent place where you will notice them.	1	2	3	4	5	6	7

Gilewski, M.J., Zelinski, E.M., & Schaie, K.W. (1990). The Memory Functioning Questionnaire for Assessment of Memory Complaints in Adulthood and Old Age. *Psychology and Aging*, 5, 482-190.

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Appendix 5- Consent Form



School of Psychology
Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099
Facsimile: 64 6 350 5673

RESEARCH PROJECT ON WORKING MEMORY

CONSENT FORM

I have read the Information Sheet for this experiment and have had the details of the experiment explained to me. My questions about the experiment have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the experiment at any time, or to decline to answer any particular questions in the experiment. I agree to provide information to the researchers (or their assistant) on the understanding that it is completely confidential.

I wish to participate in the **Research Project on Working Memory** under the conditions set out on the Information Sheet.

Signed: _____

Name: _____

Date: _____

If you would like to receive a summary of the findings from the experiment when it is completed, please provide your address in the space below.

Address: _____

Participant ID# _____

Te Kunenga ki Pūrehuroa

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Appendix 6- Health Screening Questionnaire



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RESEARCH PROJECT ON WORKING MEMORY

PARTICIPANT SCREENING QUESTIONNAIRE

Please answer the following questions by writing "Yes" or "No" next to each. Do not hesitate to ask if something is not clear.

Please note that you may refuse to answer any question. However, we cannot include someone in our research project if we do not have a completed questionnaire for that person.

1. Have you had any form of mild head injury within the last two years? _____
2. Have you ever had a moderate or severe head injury? _____
3. Have you ever been diagnosed as having a learning disability? _____
4. Have you ever been diagnosed as having an organic memory problem? _____
5. Do you consider yourself to be a heavy drinker? _____
6. Do you consider yourself to have any kind of memory impairment?

-- THANK YOU --

Participant ID# _____

Te Kunenga ki Pūrehuroa

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Appendix 7-Information sheet at completion of session



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RESEARCH PROJECT ON WORKING MEMORY

THANK YOU FOR YOUR PARTICIPATION

Thank you for participating in our research project on working memory!

The aim of the experiment in which you participated is to examine how well older adults are able to predict their performance in a memory task. The ability to predict memory performance is an index of metamemory, which is your knowledge and awareness of your memory.

Many people believe that older adults have more memory problems than younger adults do. While it is true that some older adults have serious memory problems, most do not. Furthermore, some instances of poor performance in memory tasks may occur because older adults underestimate the difficulty of the task, or how much effort is needed to perform it successfully. Such underestimation indicates a metamemory problem - that is, their metamemory lets them down, not their actual memory. Hence, it is important to study metamemory in older adults, so that we can better understand the way memory and metamemory work in later life.

Earlier research in our laboratory has shown accurate metamemory in a working memory task. Younger adults accurately predict both their overall level of performance in a working memory task, and changes in performance when aspects of the memory task are varied. The question we are investigating in this study is whether older adults also show accurate metamemory in a working memory task.

The memory task that you completed is one that is often used to study working memory. Working memory is a short-term, transient memory, rather like a mental workspace. The most important function of working memory is to hold information temporarily, either for immediate retrieval or for further processing.

Te Kunenga ki Pūrehuroa

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In this experiment, the words at the end of the sentences – which you were asked to remember -- were varied. Some people had short words on half the trials and long words on the other trials. Other people had rhyming words on half the trials and non-rhyming words on the remaining trials.

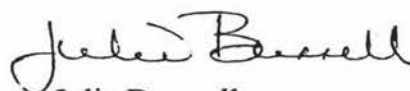
Before every trial, you were informed about the type of words that would be presented, and some of you were asked to predict how many words you would remember. After each trial, some of you were asked to estimate how well you actually performed; we call this postdiction. We will compare your predictions and postdictions with your actual performance. Because we are studying metamemory, we are more interested in how closely your predictions and postdictions correspond to your performance than in how many words you actually remember.

We will also be able to compare the results from this experiment with results obtained in earlier experiments using younger adults. This will allow us to see (a) whether memory performance differs between older and younger adults, and (b) whether metamemory accuracy differs between older and younger adults.

Once again, thanks for taking part in our experiment. We hope you found the experience interesting, and we are very grateful for your contribution to our research project.



Cheryll Craighead
M.A. Student



Julie Bunnell
Senior Lecturer

School of Psychology
Massey University
Palmerston North
(06) 350 5799

P.S. If any of your friends are also participating in the experiment, we would appreciate it if you did not discuss the experiment with them prior to their participation.

Appendix 8- Results Letter sent to interested Participants



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RESEARCH PROJECT ON WORKING MEMORY

SUMMARY OF RESULTS

Last year you participated in a research project concerned with working memory. When you completed the study, you indicated that you would like to receive a summary of the results. The purpose of this letter is to share with you the results of that study.

As nearly a year has passed since you participated in the study, it may be useful to remind you of what the study involved. The aim of the experiment in which you participated was to examine how well older adults were able to estimate their performance in a memory task. The ability to estimate memory performance is an index of **metamemory**, which is your knowledge and awareness of your own memory.

There were 12 trials in the actual experiment, and on each trial you were presented with six sentences. You were asked to decide whether each sentence was true or false, and then you were asked to recall the last word of each sentence in the order presented. Some of you participated in Experiment 1, in which the six last words in a particular trial either rhymed with each other, or did not rhyme with each other. Others participated in Experiment 2, in which the six last words in a particular trial were either short, one-syllable words or long, three-syllable words. Some of you were asked **before** each trial to predict how many words you thought you would remember in the correct order. Some of you were asked **after** each trial to postdict how many words you believed you had remembered in the correct order.

The results showed that older adults recalled more rhyming words than non-rhyming words. Predictions and postdictions for rhyming and non-rhyming words fluctuated in the same pattern as actual recall, showing that older adults had an understanding of their working memory and some degree of metamemory because to do this people would need to be aware



Te Kunenga ki Pūrehuroa

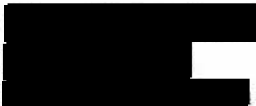
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of their performance. The results also showed that older adults recalled more short words, as expected, than long words. However, participants made the opposite predictions and postdictions, expecting to recall more long words than short words. For long words postdictions matched recall better than predictions, which showed that older adults were able to gather information about their performance during the task.

You were also asked to complete a questionnaire about your memory, and scores on the questionnaire were compared to performance on the recall task. Scores on the questionnaire were unrelated to performance on the memory task, probably because the questionnaire measured more general aspects of everyday memory, whereas the recall task involved a single and very specific aspect of memory.

The results of this study showed us that older adults are able to estimate their memory performance, using metamemory in a complex memory task.

Once again, thanks for taking part in our experiment. If you have any further questions or concerns, please feel free to contact either of us.



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