ADULT AGE DIFFERENCES IN WORD FRAGMENT COMPLETION PRIMING AS A FUNCTION OF PRESENTATION CONTEXT

by

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ABSTRACT

Indirect or implicit tests of memory assess the influence of recent experience on task performance without requiring awareness of remembering. The present experiment examined the influence of presentation context on younger (18-28 years) and older (60-70 years) adults indirect test performance. A total of 36 younger and 36 older adults participated. Presentation context was manipulated in two ways. First, target words either fit in meaningfully with the presentation context (sensible condition), or their meaning was incongruent with the context (non-sensible condition). The second context manipulation involved presenting sensible and non-sensible target words in passages, sentences or word-pairs. At test, a word fragment completion task was used to assess the influence of presentation context on indirect memory test performance.

Results indicated that target words in the sensible condition did not produce priming whereas words in the non-sensible condition did. Results also indicated that no statistically significant differences in priming were apparent across the passage, sentence, or word-pair contexts for either sensible or non-sensible target words. Additionally, the effect of age did not reliably interact with priming for either of the context manipulations.

These findings suggest that changes in an items' context influences performance on an indirect test of memory in some instances, but not others. The differences in priming between sensible and non-sensible target words are

thought to reflect differences in the match between encoding and retrieval processes. Specifically, priming is produced when the processes evoked at study match those processes required at test. Results also indicate that changes in presentation context affect the indirect test performance of both age groups similarly.

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Dedication

To Nanny,

All of this and more, is for you

and because of you.

Chapter One

Introduction

Recently, a great deal of attention has been focused on the domain of indirect or implicit memory (see Richardson-Klavehn & Bjork, 1988; Schacter, 1987 for reviews). Unlike direct or explicit tests of memory (e.g., recall and recognition) which require a subject to retrieve specific information, indirect tests require only that the subject perform an assigned task without reference to particular prior events. With indirect tests, memory is revealed as a facilitation or change in task performance that is attributable to exposure to information during a previous episode (Schacter, 1987). Word fragment completion is one example of an indirect memory test where a subject is required to correctly complete word fragments (e.g., _O_O_UT with COCONUT). Prior presentation of a valid completion for the fragment increases the likelihood of its generation, implying a form of memory for its initial presentation. This relative advantage for previously experienced words is called priming.

Much of the early work with indirect tests of memory centered on dissociations from direct tests of memory. For example, whereas direct tests typically benefit from deep and elaborative semantic encoding, the magnitude of priming effects on some indirect tests are insensitive to the levels of processing manipulation (e.g., Graf & Mandler, 1984; Hashtroudi, Ferguson, Rappold & Crosniak, 1988). Alternatively, performance on direct tests is less sensitive to changes in an item's surface characteristics, whereas priming is attenuated or

eliminated by changes, from study to test, in presentation modality (Roediger & Blaxton, 1987), typeface (Graf & Ryan, 1990; Masson, 1986), and representational format (Weldon & Roediger, 1987). Perhaps the most striking dissociation is the fact that certain amnesic patients, who exhibit severe episodic memory deficits, produce normal levels of enhancement on most indirect memory tests (see Shimamura, 1986 for a review).

Recently, several parallel effects in direct and indirect memory tests have been observed for a number of variables. Hultsch, Masson, & Small (1991) reported adult age differences for both direct (word, story and fact recall), and indirect (stem completion) tests of memory (see Howard, 1991 for a review). Similarly, lower frequency words typically produce higher levels of performance on both direct (e.g., Shepard, 1967) and indirect tests (e.g., Lewandosky, Bainbridge, & Kirsner, 1989; MacLeod, 1989). Finally, performance is superior in conditions where presentation context is reinstated at test for both direct (e.g., Thomson & Tulving, 1970; Underwood & Humphreys, 1979) and indirect tests of memory (e.g., Blaxton, 1989; Lewandosky et al., 1989).

The present study seeks to expand on the role of presentation context on subsequent levels of priming on an indirect test of memory. The present study has two main objectives. The first is to determine the effect of presentation context on word fragment completion. This will be accomplished by initially exposing target words in either a passage, sentence or word pair context and then testing the items in isolation. If context plays a role in the magnitude of priming

effects, then differences across the three conditions should be apparent. The second objective is to determine whether presentation context affects older and younger adults' performance similarly. This will be determined by comparing the performance of young and older adults in the above three conditions.

Chapter Two

Review of the Literature

This chapter reviews recent empirical and theoretical work examining the influence of presentation context on memory performance. In the first section of this chapter, work pertaining to the influence of presentation context on indirect tests of memory will be reviewed. Next, several theoretical accounts of performance on both direct and indirect tests of memory will be contrasted. Third, by examining the text recall literature, the processes utilized by younger and older adults to remember discourse will be compared. Finally, several studies using both direct and indirect tests of memory that have examined the effect of context change on memory performance by younger and older adults will be discussed.

Context effects using indirect tests of memory

This section reviews recent work examining the influence of presentation context on indirect memory performance. Typically, researchers compare performance from a condition in which presentation context remains constant across the study and test phases to one in which the context changes. This review is organized such that experiments that have contrasted word-pair presentation versus isolated words will be outlined first. Next, several experiments that have examined the effect of presenting target words in sentences will be reviewed followed by studies that have compared words in passages versus isolated words.

Both Blaxton (1989) and Jacoby (1983a) manipulated the study context of

word pairs shown to subjects by presenting them in either a context condition (e.g., HOT-COLD) or a no context condition (e.g., XXX-COLD). At test, subjects were exposed to the target words in isolation. Although Blaxton used fragment completion as the indirect measure (completion of three letter word stems into proper words), whereas Jacoby used perceptual identification (identification of briefly presented words), equivalent results were obtained. In both cases, words seen initially without context produced greater priming than did words originally presented with context.

Graf and Schacter (1985, 1987; Schacter & Graf, 1986) have also reported differences in priming as a function of changes in word context. In their paradigm, the context of the target words was manipulated at test. Subjects studied word pairs (e.g., window-reason) and were later presented with same context test items (e.g., window-rea___) or different context (officer-rea____) items. Although different context items did show a significant amount of priming, the same context items showed even more.

It is obvious that context can act to moderate the magnitude of priming effects. Altering the context by a single word either at study (Blaxton, 1989; Jacoby, 1983a) or test (Graf & Schacter, 1985, 1987; Schacter & Graf, 1986) produces marked differences in priming. More recently, several investigators have examined the effect presenting target words in sentences (Masson & MacLeod, 1992; Parkin, Reid, & Russo, 1990) or paragraphs (Levy & Kirsner, 1989; MacLeod, 1989; Oliphant, 1983) has on levels of priming on indirect tests of

memory.

Masson & MacLeod (Experiment 8A, 1992) contrasted priming performance on a perceptual identification test after reading a word on its own (e.g., movie) or as part of a sentence (e.g., On a long flight airlines often show a movie). They found that words read in isolation produced reliable priming effects, but those read in a sentence context did not.

Alternatively, Parkin et al. (experiment 1, 1990) observed that words presented as part of a sentence produced reliable priming effects on a word fragment completion task. They also observed, however, that words subsequently seen as part of a direct test of recognition memory produced even higher levels of priming. Their results suggest that words presented in sentences produce priming effects, but words subsequently seen on their own produce even larger effects. This latter result is not a product of the use of direct memory retrieval strategies since a divided attention manipulation had no effect on indirect test performance but produced lower levels of performance on the recognition test.

It is unclear why Masson & MacLeod (Experiment 8A, 1992) did not observe priming after presenting target words in sentences while Parkin et al., (1990) did, but it may be due to the nature of the encoding task used. Parkin et al., required that subjects read through each of the sentence and decide whether they made sense or not. Additionally, "subjects were encouraged not to rush", in making their decisions. Alternatively, Masson & MacLeod (1992) required that subjects only read through the sentences (Experiment 8A), and this did not

produce priming. In a subsequent condition (Experiment 8B) however, subjects spent additional time forming a mental image of the sentence and this resulted in significant levels of priming. Perhaps the additional time spent processing the sentences in Parkin et al.'s experiment and Masson & MacLeod's Experiment 8B contributed to the significant levels of priming in both conditions.

The next set of experiments examined performance on indirect tests of memory after exposing target words in isolation or embedded in passages. Oliphant (1983) compared response latencies on a lexical decision task after subjects were exposed to target words in one of three conditions. In the control condition subjects were not exposed to any of the target words prior to the lexical decision task. Both experimental groups saw the target words prior to the lexical decision task, but one group studied them in a word list, whereas the other group saw the words embedded in a preexperimental questionnaire and instructions. The first two groups replicated the results of Scarborough, Gerard, and Cortese (1979) such that the decision whether a letter string was a word or not was speeded for words seen prior to the lexical decision task. The third group exhibited no decrease in response latencies even though they had seen the target words previously in the questionnaire and instructions. Oliphant interpreted this as indicating that awareness of repetition is necessary for repetition priming to occur. The results can also be interpreted in a manner more consistent with the change in context between study and test. Priming was observed for the group who saw words in isolation both at presentation (word list) and test (lexical

decision task). Priming was not observed for the third group who saw the words embedded in text (instructions and questionnaire) and were subsequently tested using the words in isolation.

Levy and Kirsner (Experiment 1, 1989) also compared the performance of groups who read target words as part of a list, or embedded in text. They used a perceptual identification test as the measure of indirect memory. Subjects were exposed to target words either in a word list, or embedded in short (500 word) passages. Results from the perceptual identification test indicated that, relative to baseline performance subjects recognized more target words presented initially in the word list than target words initially presented in text. There was no evidence of priming in the text condition.

The final experiment pertinent to this review is by MacLeod (1989). He too contrasted the performance on an indirect test of memory after presenting target words in a list or embedded in text. He also manipulated the context of the text condition by presenting some of the words in meaningful portions of text, while others were embedded in sentences whose meaning was incongruent with the rest of the passage. In the text condition, subjects were required to read each text and cross out the sentence that did not fit in meaningfully with the rest of the passage. Three main findings came out of MacLeod's experiments: (a) Words embedded in meaningful portions of text produced priming, (b) words seen in non-sensible sentences produced additional priming, and (c) words presented in a list produced the largest amount of priming on a word fragment completion test.

The fact that MacLeod (1989) observed priming for words embedded in text, whereas Levy & Kirsner (1989) or Oliphant (1983) did not, may be due to several factors. Levy and Kirsner point out that the texts used by MacLeod were shorter than theirs and suggested, "the small amount of priming he [MacLeod] found for words originally processed in sensible sentences may disappear when longer messages are processed" (p. 414). However, Jacoby (1988) has argued that the number of words originally processed is not a critical factor in determining priming from word reading to perceptual identification.

A second potential factor are the differences in word frequencies across the three experiments. MacLeod (1989) reported that low frequency words produced higher levels of priming than high frequency words did (see Jacoby, 1983b for similar results). He suggests that the relatively high frequency words used by Levy & Kirsner (1989) and Oliphant (1983) may have minimized priming.

The final difference among the experiments was that each one used a different indirect test of memory. Recently, Witherspoon & Moscovitch (1989) demonstrated stochastic independence between perceptual identification and word fragment completion. That is, performance on one task was not predictive of performance on the other task. These differences in indirect memory tests could potentially lead to the lack of priming from passage contexts for one type of test, but the presence of priming for another. Several experiments bear on this hypothesis.

Sills (reported in MacLeod, 1989) used procedures similar to Oliphant

(1983) whereby he examined priming effects after embedding target words in experimental instructions. Unlike Oliphant, Sills used a word fragment completion test as the indirect measure of memory. He found that words initially seen in the instructions produced priming and concluded that Oliphant's result does not generalize across all types of indirect tests. Similarly, Madigan, McDowd, and Murphy (1991) reported reliable priming effects on a word fragment completion test after exposing target words in experimental instructions. It is possible therefore, that the discrepant results after presenting target words in text may be a function of the different indirect tests used.

It is clear that changing the context of an item between study and test is extremely disruptive to indirect tests of memory. In order to understand why changes in context produce differences in priming, an understanding of the processes involved in direct and indirect tests of memory is necessary.

Theoretical Explanations of Direct/Indirect Dissociations

The theoretical explanations emphasized in this section are typically classified as 'processing theories' for direct/indirect memory performance. This view contends that the dissociations between direct and indirect tests of memory are a function of different component processes recruited by each type of memory test. This differential reliance leads to direct/indirect performance dissociations is response to the same stimuli (see Masson, 1989 for a review). It should be noted however, that alternate views of the performance on direct and indirect tests are available. One such view contends that test performance for each type of test

relies upon functionally and neuroanatomically distinct memory systems. The incompatibility of the two systems is what leads to the different memory test performance (see Tulving & Schacter, 1990 for a review of their Perceptual Representation System). Since these 'systems' views are typically unable to account for findings such as dissociations among indirect tests of memory (Witherspoon & Moscovitch, 1989) and context effects, it is the processing view that will be emphasized here.

Roediger and his colleagues (e.g., Roediger, Srivinas, & Weldon, 1989a; Roediger, Weldon, & Challis, 1989b) have adopted a transfer of processing (TAP, Morris, Bransford, & Franks, 1977) account to explain dissociations among direct and indirect tests of memory. The concept of TAP specifies that retrieval is determined by the degree of overlap between study and test processing (Morris et al., 1977). Indirect tests are viewed as typically relying on data-driven processes for their retrieval. These tests rely largely on the match of perceptual processing between the learning and testing episodes. Evidence supporting this contention comes from studies that have shown changing perceptual characteristics of stimuli (e.g., type font, modality, representational format) from study to test leads to attenuation or absence of priming effects, whereas changing the amount of conceptual processes does not (see Jacoby, 1983a; Roediger et al., 1989a for a review).

Direct tests of memory, on the other hand, rely on encoding the meaning of concepts and elaborative semantic processing. Evidence of this comes from

experiments using the Levels of Processing manipulation (Craik & Tulving, 1975) whereby recall and recognition performance is superior after elaborative encoding as opposed to attending to the surface features of the stimuli.

While data-driven and conceptually driven operations are often used interchangeably with indirect and direct tests of memory, respectively, tests can be created to respond to either type of processing operations. For example, Blaxton (1989) contrasted 2 conceptually driven tasks, one indirect and one direct with 2 data-driven tasks (one direct and one indirect). She found that the tests responded to the type of processing involved, with performance on both conceptual tasks highest in the semantic elaboration condition and the data driven task performance best after perceptual encoding of stimuli.

Using the TAP framework, the attenuation of priming effects resulting from changes in context between study to test are a function of the mismatch between the processes involved in encoding and retrieval. Changing an item's context between study and test changes the processing operations recruited at each stage. For example, MacLeod (1989) suggested, "as words move from no context [list] to a non-meaningful context [crossed out] to a meaningful context [sensible] the degree of conceptual processing increases, and the degree of data-driven processing decreases" (p. 404). The decrease in priming therefore results from the mismatch between the conceptual encoding operations and the data-driven processes necessary to complete the indirect test of memory (word fragment completion). However, MacLeod did obtain small but reliable priming

effects for words embedded in sensible portions of text, suggestive of some data-driven processing being directed at the items in text.

The TAP framework has been criticized as being unable to explain a number of results from direct and indirect tests of memory. The dissociation observed by Witherspoon and Moscovitch (1989) between perceptual identification and fragment completion is contrary to the contention that these tasks both rely on similar types of processes. Similarly, direct memory tests, namely recall and recognition, have been dissociated in response to a number of experimental manipulations (e.g., Connor, 1977; Watkins & Tulving, 1975).

Some indirect tests of memory are sensitive to the conceptual interpretation of the target word, which implies that not all indirect tests of memory rely solely on data-driven processes. Masson and Freedman (1990) demonstrated that when context words induced the same interpretation of a homograph at study and test (e.g., glove-bat; baseball-bat) repetition priming effects on a lexical decision task were larger relative to when a different interpretation was biased (e.g., glove-bat; cave-bat). Lewandosky et al. (1989) report similar results using both lexical decision and word completion paradigms.

As a result of the problems with the TAP account, an alternative framework for explaining dissociations between direct and indirect tests of memory has been developed. This view stems from Kolers' work (Kolers, 1979; Kolers & Roediger, 1984) on processing operations. In this framework tests are not assumed to be either data-driven or conceptually driven, but performance

relies upon the extent to which the same processes, both perceptual and conceptual, are recruited at study and test. Processing operations are divided into 2 classes, those that aid in the initial interpretation of the stimulus, and those that subsequently elaborate on the interpretation (Graf & Ryan, 1990; Masson, 1989; Masson & MacLeod, 1992).

Interpretive encoding operations utilize both perceptual analysis of the stimulus and the context in which the stimulus is first encountered. Interpretation of a word is influenced by the knowledge activated from processing earlier words and propositions (Kintsch, 1988), as well as the perceptual aspects of the word. For example, Masson and Freedman (1990) showed that the meaning of a homograph could be altered by presenting context words that bias different meanings between study and test, and this influenced indirect memory performance. Indirect memory tasks that involve only the identification (e.g., perceptual identification), or the regeneration (e.g., fragment completion) of stimuli, rely primarily upon interpretive encoding operations (Graf & Ryan, 1990; Micco & Masson, 1991; Masson & MacLeod, 1992). Processing the retrieval cue (e.g., word fragment, briefly presented word) in an indirect test serves to reenact or redintegrate the original encoding operations (Horowitz & Pyrtulak, 1969) which yields a successful completion for that item. The magnitude of priming effects are an index of the increased integration produced by study trial processing (Graf & Ryan, 1990).

Direct memory tests are supported by both interpretive and elaborative

encoding operations. To make a judgement of prior occurrence, subjects rely on the reconstruction of the experimental situation in which the target word was originally encoded (Mandler, 1980, 1988) and the fluency with which the target is identified (Jacoby, 1984; Jacoby & Hollingshead, 1990).

Using the procedural view of indirect and direct memory, the observed decline in priming as a function of changes in context between study and test are a result of the mismatch between interpretive operations. When a word is embedded in context, its meaning is gleaned from both the perceptual analysis of the target and its' semantic relation to the context in which it was embedded. When a word is viewed in isolation however, on an indirect test of memory for example, its correct completion utilizes the perceptual characteristics of the items to establish its' meaning, since no other cues are available. The differences in the interpretive operations recruited to assign meaning to an item in isolation versus those processes used when an item is seen in context result in the attenuation of priming when context is changed between study and test (Graf & Ryan, 1990).

It is apparent from this review of the literature that changing an items context between study and test will attenuate or eliminate priming effects on an indirect test of memory. Further, this attenuation is thought to result from a mismatch between encoding and retrieval operations recruited at each stage. There are several limitations in the research reviewed thus far however. First, the majority of research has contrasted performance on two context conditions, typically comparing a context group with a group who read isolated words at

study. It would be interesting to compare the performance after exposing target words in multiple context conditions. Perhaps, as MacLeod (1989) speculates, "there is a gradient of priming as a function of prior context" (p. 403). Without comparing multiple context presentations, evidence for or against this gradient is inconclusive. A second limitation is that comparing results across experiments is problematic because different indirect tests of memory are often used. The observed dissociations among indirect memory tests (e.g., Witherspoon & Moscovitch, 1989) makes these comparisons suspect. Finally, it is unclear whether changes in context affect the indirect memory performance of all ages similarly, since university undergraduates comprise the typical subject population. There is evidence that the attenuation of priming resulting from different study/test contexts may not be as large for older adults because of the different processing operations they typically recruit.

Text Processing of Older and Younger Adults

Initially the emphasis on research into text comprehension by older adults was, in part, a function of the desire to compare younger and older adults memory performance using more ecologically valid tasks (cf. Hultsch & Pentz, 1980). Presumably older adults have experience with reading and remembering textual materials, whereas the memorization of word lists is less familiar. With the use of ecologically valid materials, and recall scoring protocols, perhaps the age differences typically found in the recall of word lists would be absent when discourse material is used. However, even with the emphasis on ecological

validity, the general consensus is that older adults recall less material than their younger counterparts. What has become clear however is that age differences are not simply a function of universal memory decline but are a result of a complex interaction between differences in individual abilities and text structures. From this pattern of interactions we may be able to predict whether changes in an item's context from study to test will influence older adults' performance on an indirect test of memory.

The finding that older adults often recall less information from text, compared to younger adults, has been attributed to their use of less efficient, shallow level encoding strategies (Craik & Rabinowitz, 1984). Alternatively, several studies (e.g., Hartley, Harker, & Walsh, 1980) have failed to find age differences in the ability to comprehend and remember text which suggests that older and younger adults may not differ in the processes used to successfully remember text, or at least that older adults are able to compensate for those processing declines (cf. Bäckman & Dixon, in press).

Smith, Rebok, Smith, Hall and Alvin (1983) examined the delayed recall performance of older and younger adults on scrambled versus clearly organized text. Subjects were required to recall double episode stories presented in three structural conditions. The standard structure condition consisted of the two episodes following each other. In the interleaved structure, the main ideas from each episode were alternated but the temporal order remained intact. In the scrambled condition, the main ideas from each episode were presented in random

order. Both age groups performed well in the standard structure and poorly in the scrambled condition. In the "interleaved" condition, the younger adults performed as well as in the standard structure, but the older adults performed as poorly as in the random condition. Smith et al. concluded that age differences in story recall are magnified by the use of poorly organized text and suggest that the aged are hampered by limits in their organizational ability.

It has also been demonstrated that older adults are less able to generate inferences from text as compared to younger adults. Cohen (1981) compared the performance of young and old adults on questions that required verbatim or inferential recall of information. Age differences were present for questions that required inferences to be made, but not for questions that required explicit information in the text to be retrieved. Both the ability to make logical and factual inferences was impaired for older adults.

Finally, Cohen and Faulkner (1984) report that older adults are less efficient at integrating information within text. They observed that older adults were more likely to answer questions about a story with a text intrusion, that is something that was mentioned in the text but is not the answer, as compared to the young. These errors reflect difficulties in integrating items within the text. Similarly, Light and Capps (1986) observed that older adults made more errors of anaphoric reference compared to younger adults, and that these errors were exacerbated by increasing the distance between the pronoun and referent.

Alternatively, Zelinski (1988) has demonstrated that while older adults

were slower in matching identical terms in coreferential sentences, age did not interact with task complexity. This was demonstrated by manipulating the nature of the matching terms (identical, related) and by increasing the number of intervening sentences between the matched pairs. Zelinski concluded that, "older people can and do integrate new information they are encountering in discourse with what they already know." (1988, p. 129).

In Zelinski and Gilewski's (1988) metaanalysis of the discourse processing literature, they found that while overall younger adults performed better than older adults, the age differences were reduced after controlling for or selecting for several variables. One of these variables was verbal ability. Several studies have shown that age differences are eliminated when highly verbal older adults are compared against young adults (e.g., Meyer & Rice, 1983; Rice & Meyer, 1986). Unfortunately, many other studies have failed to support this view (e.g., Cohen 1979; Hultsch, Hertzog & Dixon, 1984).

Another variable that has been implicated in moderating age differences in text recall is working memory capacity. Since older adults often perform poorer on measures of working memory (see Baddeley, 1986; Craik, Morris & Gick, 1990 for a review), this has been implicated as a source of the deficits typically observed in text recall performance . For example, Stine and Wingfield (1987) demonstrated that controlling for differences in working memory capacity significantly reduced, but did not eliminate, age differences in text recall performance. Unfortunately others (e.g., Light & Anderson, 1985) have not found

working memory to be a significant predictor of text recall, although age differences did exist on working memory capacity.

Recently, Hultsch, Hertzog & Dixon (1990) have examined how both verbal ability and working memory act to moderate age differences in text recall. They found that after controlling for verbal speed and working memory, the age-related variance was reduced from 18% to 4%. Therefore while controlling for the verbal speed and working memory reduced the age differences in performance, it did not entirely eliminate them.

In sum, while older adults often do not perform as well as younger adults on measures of text recall, why they don't is a subject of some controversy. Some have suggested they are hampered by deficits in working memory (e.g., Stine & Wingfield, 1987), while others suggest otherwise (e.g., Light & Anderson, 1985). Similarly, some researchers have suggested that only older adults who are low in verbal ability exhibit deficits (e.g., Meyer & Rice, 1983) but this has not met with universal acceptance (e.g., Hultsch et al., 1984). While controlling for these variables may not eliminate age differences in text recall, they do account for some of the age-related variance (e.g., Hultsch et al., 1990) and do represent important factors in determining the success of text recall.

Certainly the ability to integrate, infer and elaborately encode information benefits performance on direct tests of story recall, but how does the ability or inability to carry out these processes relate to performance on indirect tests of memory? As previously mentioned, the attenuation of priming resulting from

changes in study/test context is thought to reflect a mismatch in processing operations at each stage. Contextually bound items are encoded based on their perceptual characteristics as well as the conceptual relationship they have with the other context items. At test, primarily integrative or perceptual processes are recruited in order to successfully complete an indirect test of memory. It is this mismatch between the interaction of conceptual and perceptual encoding operations and the primarily perceptual retrieval processes that results in the attenuation of priming. However, the mismatch between encoding and retrieval processes may not be as dramatic for individuals whose conceptual processing ability is limited. As the literature on aging and text comprehension suggests, older adults may be those individuals. Alternatively, it could be argued that those processes required to successfully recall text are more demanding than those needed to integrate target words in context. Consequently, older adults may be equally affected by changes in study/test context. Several findings using both direct and indirect tests of memory suggest otherwise.

Context Effects With Younger and Older Adults

Simon (1979, Experiment 2) compared the performance of young, middle-age and old adults on a free or cued recall task. Subjects were required to remember the last word of a sentence and were tested by free recall or recall cued by phonemic (the first two letters of the to-be-remembered word), semantic (synonym) or context (sentence frames) cues. Simon observed that the phonemic cues were effective for both the middle-age and oldest groups, but not for the

youngest age group. The semantic cues were effective in both the young and middle aged group. Finally, the context cues were effective only in the youngest group. Simon suggested that young adults were able to use semantic and contextual information to elaborately encode each word. The phonemic cues were ineffective because for the young, "the parts (ie. the words) were lost in the meanings of the whole sentences" (p. 121). Older adults, on the other hand, were less able to integrate contextual information and process the items semantically as evidenced by the ineffectiveness of the semantic and context cues in cuing recall.

Simon & Craik (cited in Craik & Simon, 1980) also observed that older adults were less able to utilize contextual information while recalling words. They had subjects remember the last word of a sentence and cued recall with either context-specific cues (adjectives that had appeared in the sentences) or with general cues that had not appeared in the sentence (e.g., the meaning of the word). For young adults, the context-specific cues were most effective whereas for older adults performance was greater using the general cues. They suggested that older adults may be unable to encode or retrieve contextual information as effectively as younger adults.

Cohen and Faulkner (1983) found that older adults actually performed better than younger adults when they were provided with contextual information. They examined word recognition latencies for words and non-words presented with or without sentence contexts. They also examined whether there were age differences in contextual facilitation for sentences with highly predictable target

words versus low predictable words. No age differences in recognition latencies were observed in the high predictability condition, but for low predictability words, the old showed greater contextual facilitation effects. Similarly, when auditory word recognition was tested with or without context against a background of white noise, older subjects showed superior contextual facilitation. They concluded that older adults compensated for the deterioration in stimulus quality by more effective use of contextual information.

While Simon's work (1979; Simon & Craik, 1980) suggests that older adults may not be affected by changes in study and test context, Cohen and Faulkner's (1983) results suggest that older adults may be equally or more affected compared to younger adults by these changes. However, both Simon and Cohen and Faulkner used direct measures of memory, whereas, in the present experiment, interest lies in how changes in context affects indirect memory performance. The next two experiments describe the effect of manipulations in study/test context on indirect test performance for both younger and older adults, and may provide some insight into how both age groups will perform in the present study.

Howard, Frye, & Brune (1991) reported age differences on a test of indirect memory for new associations. Their procedure was similar to that used by Graf and Schacter (1985, 1987) whereby subjects studied word pairs and were later presented with same or different context items on a word stem completion task. Age differences were present when time constraints of 8 or 15 seconds were allotted for presentation (Experiment 1 and 3, respectively), but not when the

presentation of word pairs was self-paced. Indirect memory for new associations is thought to require the integration (e.g., Micco & Masson, 1991), or elaboration (e.g., Graf & Schacter, 1985, 1987) of items within the word pair. The age differences observed by Howard et al. imply that the older adults were unable to sufficiently elaborate or integrate the items to facilitate subsequent priming performance. While priming performance under the self-paced condition was reliable, the elaborations older adults produced in response to word pairs were judged to be of poorer quality as compared to the young. Howard et al. concluded that older people are less likely than younger people to produce elaborations of high quality.

Finally, Davis et al. (1990) examined whether biasing the low frequency member of a homophone pair influenced its later spelling similarly for younger and older adults. They found that young adults were more likely to use the low frequency spelling biased at study, compared to older adults. This suggests that presentation context was not as influential in biasing the lower frequency homophone for older adults. Davis et al. caution that the high baseline performance by the elderly may have obscured priming effects, since older adults produced significantly more baseline items compared to the young.

It is evident that while indirect/implicit memory has been the focus of a plethora of research, much of this work has focused on how younger adults perform on these tasks. It is possible that by studying both younger and older adults performance on these tests we may gain insight into indirect memory itself,

and also learn more about how older adults perform on different classes of memory tests.

Chapter Three

Objectives and Hypotheses

Objectives

In sum, the present study examines the influence of presentation context on younger and older adults' performance of an indirect test of memory. There are two main objectives in the present study. The first is to determine the effect of presentation context on word fragment completion priming. Presentation context was manipulated in two ways. First, by comparing the performance of words presented in sensible or non-sensible contexts; and second, by contrasting the priming levels after words were exposed in either passages, sentences or word-pairs. In addition to examining context effects this study also examined whether changes in context affected older and younger adults' word fragments completion performance similarly.

Hypotheses

Differences in priming were expected between the sensible and non-sensible conditions based on prior research, and the theoretical interpretations of direct/indirect dissociations. It was expected that words in the sensible condition will show little or no priming by virtue of the mismatch between encoding and retrieval operations. This mismatch is a result of the words being integrated with the context at study, whereas the words are tested in isolation. The same processes recruited to identify the target word at study do not match those required to successfully complete the word fragments and since the magnitude of

priming effects are an index of this match (cf. Graf & Ryan, 1990; Masson, 1989), the levels of enhancement for words seen before will be little or non-existent.

For the non-sensible condition, the target words may be processed in partial isolation at study by virtue of them not fitting in meaningfully with the rest of the context. Therefore it is expected that the mismatch in processing operations will not be as great for non-sensible target words and this will result in higher levels of priming in this condition.

Overall, it is expected that non-sensible target words will produce more priming than sensible target words which may not differ from baseline performance. This result is predicted for all three presentation contexts.

The differences in priming expected among the passage, sentence and word-pair contexts are less clear. This is due to the fact that, although many of the presentation contexts were examined previously, they were often studied using different indirect tests of memory. If as MacLeod (1989) suggests, "there is a gradient of priming as a function of prior context" (p. 403), we might expect differences among the three presentation contexts. The most likely outcome is that words in the word-pair context should exhibit greater priming than those in the sentence context, which should prime more than the target words in the passage context. This is based on the assumption that as target words are embedded in more extensive contexts, (a passage versus a word-pair for example) the degree of contextual integration goes up, while the degree of individual item processing goes down. Using this assumption, perhaps the mismatch in encoding

and retrieval operations will be greater in the passage context as compared to the sentence or word-pair contexts. This would result in a gradient of priming from word-pair to passage of the sort described by MacLeod (1989).

Alternatively, Graf & Schacter (1989) have noted that elaborative processing has an impact on direct tests of memory only. After the items are integrated with the context, elaborative processing will affect performance on direct tests of memory for those items, but does not affect indirect tests of memory. Considering this result we might expect no differences in the degree of priming across presentation contexts because target words in all three presentation contexts have become sufficiently integrated with the context, even though the target words may undergo a different degree of elaborative encoding across the three contexts.

This study also seeks to determine whether changes in presentation context affect all ages similarly. It has been demonstrated that older and younger adults differ in the way they encode material and that these differences may make older adults less susceptible to the influence of presentation context. Alternatively, some studies have suggested that older adults are equally affected by context (cf. Cohen & Faulkner, 1983), and therefore, both age groups may be equally affected by the changes in context between study and test. This will be examined by contrasting indirect memory test performance of younger and older adults after presenting target words in the above context conditions.

Additionally, measures of working memory and verbal ability will be

included in the present study. If impairments of working memory and verbal ability prevent older adults from encoding elaborately, as has been suggested (see Cohen, 1988; Hultsch & Dixon, 1984 for a review), then those individuals who are impaired in these domains may be less susceptible to changes in study/test context. Again however, if these variables do not influence the way older adults process the presentation context then no correlations between verbal ability, working memory and priming will be expected.

Chapter Four

Methods

Participants

Participants were 36 young adults (18 Male & 18 Female) and 37 older adults (19 Male & 18 Female), recruited as unpaid volunteers. Young participants (aged 18-28 years) were drawn from the undergraduate subject pool at the University of Victoria. The older sample (aged 60-70 years) was recruited through community appeals requesting volunteers for research in memory and aging, or through previous participation in psychological research. One older male participant did not complete the entire experimental session, and therefore, his data were excluded from further analyses. This resulted in 36 young adult (M = 20.75 years) and 36 older adult (M = 65.56 years) participants.

The educational, and self-rated health characteristics of the sample are summarized in Table 1. Within the younger group, all participants had completed at least 12 years of schooling, while 25% had completed at least 16 years. This compares with 72% and 18%, respectively for the population of Canada as a whole (Statistics Canada, 1989). Within the older group, 87% had completed at least 12 years of schooling, and 39% had completed at least 16 years. This compares with 35% and 8%, respectively for the population as a whole. There was a significant Age X Gender interaction for years of education ($F(1,67) = 12.16, p < .01$) indicating that in the younger age group, women had more years of education than men, with the pattern reversed in the older age group.

Table 1

Demographic and Health Characteristics of the Sample

Variable	Age 18-28 Years		Age 60-70 Years	
	Women (N=18)	Men (N=18)	Women (N=18)	Men (N=18)
Age				
M	21.22	20.28	64.61	66.50
SD	2.67	2.32	3.45	2.64
Years of Education				
M	15.67	13.94	13.72	16.17
SD	1.94	1.39	2.42	3.40
Self-rated health[a]				
M	1.56	1.67	1.44	1.44
SD	.62	.69	.51	.62
Illness Episodes[b]				
M	5.61	5.11	4.33	5.18
SD	2.89	2.56	2.22	3.07
Chronic Conditions[c]				
M	1.11	.94	2.44	2.94
SD	1.37	1.21	1.95	2.07

(Table 1 con't)

Prescription and Non-Prescription Drug Use[d]				
M	.89	.22	1.67	1.11
SD	.76	.43	1.33	1.41

[a] Compared to a perfect state of health (from 1 = very good to 5 = very poor).

[b] Hospital stays, visits to the doctor, and days home sick in bed (higher score indicates more problems).

[c] Incidence and seriousness of 26 chronic conditions (higher score indicates more problems).

[d] Number of prescription and non-prescription medications currently being taken.

This reflects the fact that many of the young female participants had graduated or were in their third or fourth year of university, whereas the males in this group were primarily first-year students.

All but one of the youngest subjects was enrolled full-time in university studies with the other young adult enrolled part-time. None of the young participants held full-time jobs, but approximately 42% were employed part-time. Most of the older participants were retired from the work force or were full-time homemakers. None of these participants were employed full-time, but 2 participants (6%) were employed part-time.

Self-ratings of health and self-reported illness episodes reflected the generally healthy nature of the sample. On a five-point rating scale, 97.2% of the young and 91.7% of the old rated their health as good or very good. None of the participants rated their health as poor or very poor. Older adults reported a significantly higher incidence of chronic illness' ($F(1,60)=15.62$, $p<.001$) than the young. Older adults also reported more prescription drug use ($F(1,60)=10.43$, $p<.01$), and overall females used more prescription drugs than males ($F(1,60)=5.85$, $p<.05$).

Design

Two base lists of target words comprising 28 items each were constructed. Further, each list was divided so that one half of the items would appear in a sensible context, and the other half appearing in non-sensible contexts (described below). Although subjects were eventually tested on all 56 items, only one base

list was presented for study. The studied base list was counterbalanced across subjects so that half of the subjects studied base list 1 and the other half studied base list 2.

Materials

Measurement of Indirect Memory Performance

Target Words. Fifty-six target words, and their corresponding word fragments, were selected from the appendix of MacLeod (1989). The words were low in frequency and 7 to 8 letters in length. The words were divided into two lists (A & B). Each list was then divided in half, with one half of the words to appear in sensible contexts, and the other half to appear in non-sensible contexts (described below).

Word Fragment Completion. The word fragments of all 56 target words were presented in a typed booklet. The fragments were randomly ordered with the limitation that no more than 3 fragments from each list (A & B), or each condition (sensible, non-sensible) could follow one another. Each word fragment had only one legitimate completion. Subjects were given 15 minutes to complete as many fragments as they could, in any order they desired. Indirect memory was assessed by determining for each list of word fragments the proportion that were correctly completed. For each subject, the list of items seen was classified as target items. Items were classified as target items only if they had been seen in one of the presentation contexts, and had been correctly identified as sensible or non-sensible. The list that was not seen was classified as baseline items.

Cognitive Abilities

Word Similarities. This task was taken from the Kit of Factor Referenced Cognitive Tasks (Ekstrom, French, Harman, & Dermen, 1976). The word similarities task requires subjects to recall as many words as they can that have meanings that are the same or nearly the same as a set of target words. The task was presented in a typed booklet and subjects were given 6 minutes to complete the test. The number of correct similarities was the measure used in the present analyses.

Vocabulary. This was indexed using the Nelson-Denny Vocabulary Test (Forms C & D). These are five-choice recognition vocabulary tests. The test forms were counterbalanced across subjects. The task was presented in a typed booklet and subjects were given 10 minutes to complete the test. The number of correct items, out of a possible 100, was used as the measure in the present analyses.

Reading Comprehension This domain was indexed using the Nelson-Denny Reading Comprehension Test (Forms C & D). Subjects were asked to read eight short factual stories presented in a typed booklet. Immediately after reading each story, subjects answered a set of five-choice recognition-type questions. Subjects were allowed to look back through the passage to answer the questions. They were also allowed to review their answers at the end of the final passage, if time permitted. Subjects were given 20 minutes to complete the task. The number of correct answers, out of a possible 36, was used as the measure in

the present analyses.

Working Memory This domain was indexed using the verbal sentence construction task developed by Hultsch, Hertzog, & Dixon (1990). Subjects read aloud a series of sentences presented on flash cards. One word of each sentence, printed in capital letters and underlined in red, was designated as the word subjects were to keep in mind while processing the series of sentences. At the end of the series, the subject was to report the target words in order. The reported target words formed a new sentence. Sets of 3, 4, 5, & 6 sentences yielding new sentences 3, 4, 5, & 6 words long were used. There were three sets of each length, for a total of 12 items. The score consisted of the number of sentences correctly reported. Pilot testing of this task with a sample of 70 undergraduates indicated that its correlation with the Nelson-Denny Reading Comprehension Test was significant (.38), as well as higher than that of Daneman and Carpenter's (1980) frequently used reading span measure with the Nelson-Denny test (.26) (Hultsch et al., 1990).

Presentation Context. Subjects were randomly assigned to one of three presentation contexts. In the passage context, subjects were asked to read short narrative texts on a computer screen. The passages were taken from MacLeod (1989). Disguised as a task to measure reading speed, subjects were required to read through the text and indicate, by pressing a button on a computer keypad, when they came across a sentence that did not fit in meaningfully with the rest of the passage. Once the button was depressed, subjects read the incongruent

sentence aloud to ensure the correct sentence was located. The subject then proceeded onto the next passage by pressing another button on the keypad. The task was self-paced, and subjects read a total of 14 passages. Two target words were embedded in each passage, one in a sentence whose meaning was congruent with the rest of the text, with the other in the incongruent sentence that was to be isolated. Thus, each subject was exposed to 28 target words in total. The latency to respond to the non-sensible sentence was recorded (in milliseconds) by the computer for words that were correctly isolated. The order of the passages was invariant across trials.

The sentence context used a semantic decision task modeled after the procedures of Palmer, MacLeod, Hunt, & Davidson (1985). Subjects were asked to decide whether a sentence appearing on the computer screen was sensible or not (e.g., "Some university students were lucky to find summer jobs." vs. "The aardvark had a litter of ten kittens this morning."). Subjects responded by pressing one of two buttons on a keypad, and the latency of this response (in milliseconds) was recorded by the computer for items that were answered correctly. After a decision was made, a message appeared below the sentence providing feedback on correctness of the response and the next sentence appeared on the screen. Subjects were given a rest break after 20 and 40 sentences had appeared. A total of 56 decisions were made. Subjects were exposed to 28 target words, half seen in sensible sentences, with the other half in non-sensible sentences. Twenty-eight filler sentences (14 sensible, 14 non-sensible) were also

presented. The items were presented randomly with the condition that no more than 3 sensible or non-sensible sentences could be seen consecutively. The order of the sentences was invariant across trials.

The word-pair context used lexical decision task procedures. Subjects were asked to decide as rapidly as possible whether a word-pair, appearing on the computer screen, consisted of similar items or not. A word-pair contained similar items if both items were real English words (e.g., royal-monarch) or both were non words (e.g., foople-dweezil). A word-pair was dissimilar if one item was a real word with the other a non word (e.g., repert-plankton). Subjects responded by pressing one of two buttons, and the latency of this response (in milliseconds) was recorded by the computer for items that were responded to correctly. The correctness of their response was displayed below the word pair after the decision was made and the next word-pair was presented. A rest break was given after the 20th and 40th word-pairs. A total of 60 decisions were made. Subjects were exposed to 28 target words, 14 in similar word pairs and 14 in dissimilar pairs. Target words were randomly assigned to occupy the first or second position of the word pair. In the similar real word pair, target words were paired with a medium frequency semantically related word. In the dissimilar pair, target words were paired with a non-word 5 to 8 letters in length. Subjects were also exposed to 32 filler items (14 similar real word pairs, 4 similar non word pairs, and 14 dissimilar pairs). The word pairs were presented at random with the limitation that no more than 3 similar or dissimilar word-pairs could be seen consecutively. The

order of word-pairs was invariant across trials.

Procedures. Subjects were tested individually in a single session approximately one and a half hours in length. The order of the tasks administered was: Demographic questionnaire, Word Similarities task, Vocabulary test, Reading Comprehension test, presentation of Target Words, Working Memory task, and Word Fragment Completion task. The order of the tasks was invariant across subjects. Subjects were not informed that their memory for the target words would be tested. The study and test phases of the indirect test of memory were separated to prevent subjects from employing direct retrieval strategies to complete the word fragments. Additionally at the end of the experimental session subjects were asked, "Whether they noticed anything about the word fragment completion task?" They were questioned to determine if subjects were aware that some of the word fragments had been seen before. If subjects were unaware, the experiment ended and they were debriefed. If subjects were aware, they were asked whether this influenced the way in which they completed the word fragments, and were then debriefed about the nature of the study.

Chapter Five

Results

This chapter is divided into three main sections. First, analyses of the effects of age and presentation context on word fragment completion performance will be discussed. Additionally, the effect of being aware of the prior presentation of valid completions for the word fragments on subsequent priming performance will be analyzed. In the second section, the effects of age on the performance of the various cognitive tasks will be examined. Finally, the relationship between word fragment completion performance and performance on the cognitive tasks across age groups and presentation contexts will be discussed. For all comparisons, the alpha level was set at .05.

Orienting Tasks

Before the results of the word fragment completion task will be described, subjects' performance concerning the response latencies and response correctness in the orienting tasks will be examined. Since each context used a different method of presentation (ie., passage, sentence, or word-pair), analyses of the age differences in performance were done separately by context condition. For each context, Analyses of Variance (ANOVA) were computed on the response latencies for each age group. The means and standard deviations for each of the three speed variables are presented in table 2. Similarly, analyses of age differences in judging the sensible and non-sensible words correctly were done separately by context condition.

Table 2

Means and Standard Deviations for Response Latencies (in Milliseconds) Across Each Context Condition

Variable	18-28 Years (N=36)	60-70 Years (N=36)
Passage		
M	11954.79	12741.35
SD	4000.89	5439.96
Sentence		
M	2898.16	3536.75
SD	1019.53	1352.00
Word-Pair		
M	1490.24	1839.81
SD	349.05	378.98

In the passage context, older adults correctly identified 96.4% of the incongruent phrases and younger adults correctly identified 94.6% of them. This difference was not statistically reliable ($F(1,23) = 1.16$). There was also no significant difference between the latencies by which each age group located the incongruent sentence ($F(1,23) = .16$).

In the sentence context, older adults correctly judged 93.4% of the sensible sentences and 91.1% of the non-sensible sentences. Younger adults performance ranged from 95.8% correct in the sensible condition to 93.4% correct in the non-sensible context. There were no age differences on either correctly judging sensible or non-sensible sentences ($F(1,23) = .82$; $F(1,23) = .76$, respectively). Similarly the latency to respond correctly did not vary reliably with age ($F(1,23) = 1.71$).

Finally, older adults correctly identified all of the sensible word-pairs and 89.8% of the non-sensible pairs. Younger adults, on the other hand, identified 94.4% of the sensible word-pairs and 78.6% of the non-sensible pairs. For the sensible word-pairs, older adults reliably identified more pairs correctly ($F(1,23) = 4.71$, $\omega^2 = .13$, $MS_e = .32$). The age difference for the non-sensible pairs was also in favour of the older adults but was marginally significant ($F(1,23) = 3.81$, $p = .064$, $\omega^2 = .10$, $MS_e = 3.45$). There were also significant age differences in the latency to correctly identify the word-pairs with older adults responding more slowly than younger adults ($F(1,23) = 5.52$, $\omega^2 = .16$, $MS_e = 145456.51$).

Word Fragment Completion by Age and Context Condition

A 2 (sensibility) X 2 (priming) X 2 (age group) X 3 (context) mixed design Multivariate Analysis of Variance (MANOVA) was computed on the target and baseline scores from the word fragment completion task. The within subjects factors in the design were sensibility and priming, with age group and context serving as the between subjects factors. Word fragment completion performance was calculated for only those target words that subjects judged correctly in the orienting tasks. Analyses revealed a significant Priming by Sensibility interaction ($\underline{F}(1,66) = 30.20$, $\omega^2 = .29$, $MS_e = 1.53$) indicating that words in the non-sensible condition produced more priming than words in the sensible condition. None of the other interactions of Age, Context, Sensibility with Priming were significant.

The remainder of the analyses were done separately for items seen in the sensible or non-sensible conditions. This was done for two reasons. First, initial analyses revealed a significant Priming X Sensibility interaction. This makes the effect of priming difficult to interpret when both the sensible and non-sensible items are combined since the priming of one type of item may mask performance on the other type. For example, for the above analyses the effect of priming was non-significant ($\underline{F}(1,66) = 2.46$). It may be the case however, that for non-sensible words there was significant priming, but this performance was masked by the lower performance for the sensible words. Second, due to incomplete counterbalancing, the sensible and non-sensible items were different sets of words. Subsequently, it is difficult to interpret whether an interaction with sensibility results from differences in encoding processes, or differences in item structure.

2 (priming) by 2 (age group) by 3 (context) mixed design MANOVA's were computed on the target and baseline scores from the word fragment completion task, separately by sensibility condition. The target and baseline scores constituted within subjects factors in the design, with age and presentation context being between subjects factors. Table 3 shows younger and older adults word fragment completion performance for words seen in the sensible condition, across all three presentation contexts. The MANOVA for words seen in the sensible condition revealed no significant effects for Priming ($F(1,66) = .14$); that is fragment completion performance was no different for target or baseline words. The interactions of Age by Priming ($F(1,66) = .06$), Context by Priming ($F(2,66) = .03$), and Age by Context by Priming ($F(2,66) = .05$) were also non-significant. These results indicate that there was not a reliable advantage for words seen before on word fragment completion for either age group in any context condition.

Table 4 shows younger and older adults' word fragment completion performance for words seen in the non-sensible condition, across all three presentation contexts. The MANOVA on words seen in the non-sensible condition revealed an overall effect of Priming ($F(1,66) = 23.95$, $\omega^2 = .24$, $MS_e = 3.45$) with target words being correctly completed more often than baseline words. The interactions of Age X Priming, Context X Priming, and Age X Context X Priming were not significant however ($F(1,66) = .16$; $F(2,66) = 1.97$; $F(2,66) = .51$, respectively). Paired t-tests were conducted to determine whether there were

Table 3

Word Fragment Completion Performance for Words Seen in the Sensible Condition by Context and Age Group

		Passage		Sentence		Word-Pair	
		Young	Old	Young	Old	Young	Old
Variable		(N=12)	(N=12)	(N=12)	(N=12)	(N=12)	(N=12)
Target	M	.16	.18	.22	.13	.18	.20
	SD	.09	.12	.21	.18	.11	.18
Baseline	M	.17	.17	.22	.11	.17	.20
	SD	.08	.16	.21	.11	.18	.16
Priming	M	-.01	.01	.00	.02	.01	.00
	SD	.16	.17	.09	.11	.18	.14

Table 4

Word Fragment Completion Performance for Words Seen in the Non-Sensible Condition by Context and Age Group

		Passage		Sentence		Word-Pair	
		Young	Old	Young	Old	Young	Old
Variable		(N=12)	(N=12)	(N=12)	(N=12)	(N=12)	(N=12)
Target	M	.47	.36	.35	.26	.35	.34
	SD	.15	.16	.23	.16	.17	.19
Baseline	M	.26	.23	.30	.18	.23	.23
	SD	.11	.15	.17	.17	.12	.13
Priming	M	.21	.13	.05	.08	.12	.11
	SD	.24	.15	.22	.14	.17	.25

reliable effects of priming for all context and age groups. This revealed significant levels of priming in all contexts except for older adults in the word-pair context ($\underline{t}(11) = 1.48$) and for younger adults in the sentence context ($\underline{t}(11) = .72$). The significant $\underline{t}$ values for older adults were $\underline{t}(11) = 3.02$ in the passage context and $\underline{t}(11) = 1.92$ in the sentence context. For younger adults the $\underline{t}$ values in the passage context were $\underline{t}(11) = 3.11$ and $\underline{t}(11) = 2.32$ in the word-pair context.

While none of the interactions between age, context and priming were statistically reliable, mean level differences in priming did exist across presentation context and age groups. Since differences between the contexts were predicted a priori, several analyses were conducted to explore the nature of these differences. It should be noted that these analyses are exploratory, and since the overall effects in the MANOVA were not significant, the results should be interpreted with caution. Separate repeated measures MANOVA's were performed on different pairings of context conditions. Analyses comparing performance in the passage condition against that in the sentence condition revealed an overall effect of Priming ($\underline{F}(1,44) = 18.00$, $\omega^2 = .25$, $MS_e = 3.17$). The Context X Priming interaction was also reliable ($\underline{F}(1,44) = 4.26$, $\omega^2 = .05$, $MS_e = 3.17$) indicating higher levels of priming in the passage context. Neither the Age X Priming or Age X Context X Priming interactions were significant. For both of the other context comparisons, sentence with word-pair and passage with word-pair, only the effect of Priming was statistically reliable ($\underline{F}(1,44) = 8.89$, $\omega^2 = .14$, $MS_e = 3.42$; $\underline{F}(1,44) = 22.51$, $\omega^2 = .31$, $MS_e = 3.75$, respectively).

The analyses of the effect of being aware that some of the word fragments had been seen before was conducted to determine whether awareness resulted in higher completion performance. If so, this would undermine the assumption that increased target fragment completion resulted from the influence of indirect memory and not from subjects' employing direct memory retrieval strategies. Subjects were assigned scores of 0, if they were unaware that the words had been presented earlier; 1, if they were aware and reported that this did not influence how they completed the word fragments; or 2 if they were aware and reported that this did influence how they completed the fragments. None of the subjects in either age group stated the they were aware and this led them to actively try to retrieve words to fit the fragments.

Due to experimenter error, only 58 of the 72 subjects were asked whether they were aware of seeing the words before. All of the younger subjects were asked, but only 22 of the older subjects were. For older adults the breakdown of complete data by context was 7 subjects in both the passage and sentence contexts and 8 subjects in the word-pair context.

Since priming was significant in the non-sensible condition only, the analyses were performed solely on these items. In the passage context, 42% of the young and 8% of the older adults were aware that the words had been seen before. In the sentence context, 42% of the young adults were aware while none of the older adults were. Finally, 25% of the young and 17% of the old were aware of the repetition of the words in the word-pair condition.

A 2 (age) x 3 (context) X 2 (awareness) repeated measures MANOVA was computed on the target and baseline scores from the word fragment completion task. Analyses indicated that none of the interactions with awareness were statistically reliable. These include: Aware X Priming ($F(1,47) = .08$), Age X Aware X Priming ($F(1,47) = .41$), Context X Aware X Priming ($F(2,47) = .43$) and Age X Context X Aware X Priming ($F(1,47) = .41$). These analyses indicate that no systematic relationship existed between priming and awareness of previous exposure to the word fragments.

Cognitive Tasks by Age and Context Condition

A 2 (age group) by 3 (context) between subjects MANOVA was computed on the dependent measures: word similarities, vocabulary, story recall and working memory. There was no overall effect for Context (Wilksλ =.899, $F(8,124) = .85$) or Age by Context (Wilksλ =.895, $F(8,124) = .88$). Since performance on the cognitive measures did not vary systematically across context conditions, Table 5 shows the means and standard deviations for the measures by age group only.

Analyses indicated an overall effect for age group (Wilksλ =.747, $F(4,66) = 5.57$). The only univariate test that was significant however was for story recall ($F(1,70) = 5.66$, $\omega^2 = .07$, $MS_e = 25.02$), with younger adults outperforming older adults.

Relationship between Priming and Performance on Cognitive Tasks

Tables 6 and 7 show the intercorrelations between priming and

Table 5

Means and Standard Deviations for Cognitive Measures by Age Group

Variable	18-28 Years (N=36)	60-70 Years (N=36)
Word Similarities		
M	12.28	11.57
SD	3.71	5.12
Vocabulary		
M	62.61	67.09
SD	17.41	17.27
Story Recall		
M	23.42	20.60
SD	4.16	5.71
Working Memory		
M	9.17	8.43
SD	2.02	2.33

performance on the cognitive tasks for the sensible and non-sensible conditions respectively. The correlations were collapsed across age groups for 2 main reasons. First, the analyses of age differences in priming indicated that no reliable differences were present. Second, by not collapsing across age groups, this would result in 12 subjects per correlation coefficient. Cell sizes this small make it difficult for the correlation to be statistically significant. With numbers this small, the reliability of the correlation can also be called into question.

For words in the sensible condition, only one correlation was statistically significant at the .05 level. This was the correlation between priming in the sentence context and working memory performance ($r(24) = .43$). This indicated that higher working memory scores was related to greater levels of priming. It must be cautioned that given the relatively large number of correlations compared (21 for both sensible and non-sensible target words) the probability of Type I error is quite high. Since priming in the sensible condition was not significant, it seems likely this correlation may be spurious.

For words in the non-sensible condition, none of the correlations were statistically significant.

Table 6

Intercorrelations Between Priming and Performance on the Cognitive Tasks in the Sensible Condition

Variable	Passage (N=24)	Sentence (N=24)	Word-Pair (N=24)
Age	.06	.06	-.06
Years of Education	-.09	-.11	-.09
Story Recall	-.10	.11	-.14
Word Similarities	-.10	.15	-.22
Vocabulary	-.05	.22	-.25
Working Memory	.26	.43*	-.03
Response Latency	.18	-.08	.02

* $p < .05$

Table 7

Intercorrelations Between Priming and Performance on the Cognitive Tasks in the Non-Sensible Condition

Variable	Passage (N=24)	Sentence (N=24)	Word-Pair (N=24)
Age	-.25	.08	.02
Years of Education	-.17	-.03	-.33
Story Recall	-.17	-.05	-.09
Word Similarities	-.03	-.22	.23
Vocabulary	-.11	.16	.02
Working Memory	.05	-.06	.14
Response Latency	.09	.10	-.14

* $p < .05$

Chapter Six

Discussion

The results of the present analyses provide evidence relevant to our two questions of interest: (a) Do changes in presentation context influence the magnitude of priming on a word fragment completion test? and (b) Do these context changes affect older and younger adults performance similarly?

Influence of Context on Priming

Target words seen in the non-sensible condition produced more priming than target words seen in the sensible condition. Significant levels of priming for non-sensible target words were observed for both age groups in the passage context, for the older adults in the sentence context, and for younger adults in the word-pair context. In the sensible target word condition, there was no benefit in having seen the words before on subsequent word fragment completion performance in any of the three context conditions.

These results are consistent with the expectation that whether a word fits in meaningfully with the context influences the way the item is processed in relation to the context that it is embedded. Non-sensible target words are less likely to be integrated with the context, by virtue of them not fitting in meaningfully. This implies that they are more likely to be processed individually as a word. Subsequently, the processes used to successfully complete an isolated word fragment may be similar to those used to initially identify a word that is isolated in context. Since the magnitude of priming effects are an index of the match

between study and test processing (cf. Graf & Ryan, 1990; Masson 1989), non-sensible target words produced priming.

Sensible target words on the other hand, are more likely to be integrated with the presentation context since they fit in meaningfully. This results in a mismatch between study/test processing, and consequently, priming levels are not significant in this condition.

These results are consistent with expectations from previous studies that have manipulated study/test context. The finding that non-sensible target words produced greater priming than sensible target words confirms MacLeod's (1989) results and extends them to sentences and word-pairs. Similarly, the lack of priming observed by Levy & Kirsner (1989) for words embedded in text parallels the results of the present study. The non-significant priming for sensible target words in the sentence context is consistent with Masson & MacLeod's (1992, Experiment 8A) results using a perceptual identification test. Finally, the non-significant priming for target words embedded in sensible word-pairs is consistent with Durgunoglu & Neely (1987) who found that semantically unrelated words produced priming on a lexical decision task, but semantically related pairs did not.

Several inconsistencies do exist between the present experiment and previous studies, however. For example, MacLeod (1989) observed priming for sensible target words in the passage context using the same materials and indirect test of memory as the present study. Similarly, several investigators (Masson & MacLeod, 1992, Experiment 8B; Parkin et al, 1990) observed significant priming

for sensible target words embedded in sentences whereas the present study did not. Finally, Graf & Schacter (1985) tested word-stem completion performance for items whose context changed between study and test and found reliable priming effects. The results from the sensible target words in the word-pair context of the present experiment, the condition most similar to Graf & Schacters' context change condition, did not replicate their findings.

The discrepancies noted above could be a function of several things. First, an interpolated task was included between the study and test phases of the present experiment, whereas many of the above mentioned studies failed to do so. This could alter the results in two ways. Without an interpolated task, subjects may be more aware of the relationship between the study and test phases. This could lead to the recruitment of explicit retrieval strategies to facilitate performance on the indirect test of memory. Since in the present experiment subjects were asked whether they were aware that some of the words had been seen before and their awareness did not lead to significant differences in priming, the use of direct retrieval strategies to perform in the present experiment seems unlikely. This cannot explain why the present results differ from those of Graf & Schacter (1985) however. In their experiments they assess the influence of direct strategies by including a condition that is known to influence direct retrieval strategies but not indirect strategies. If indirect test performance is not affected by this manipulation, they can be confident that the performance was not contaminated by direct strategies.

It is also possible that during the intervening time between study and test the "seen" items became unprimed, or subjects simply forgot the words they had seen. Sloman, Hayman, Ohta, Law, and Tulving (1988) noted that within 5 minutes, priming performance on a word fragment completion task dropped dramatically. Since word fragment completion was not affected by interference, they attributed the decline in performance to forgetting. It is possible that the interpolated working memory task, which takes 10-15 minutes to administer, caused a sufficient delay between study and test to result in inconsistencies between studies that did not include such a task (e.g., MacLeod, 1989).

While the use of interpolated tasks may help to explain some inconsistencies, it does not resolve differences in performance among studies that did involve delays ranging from several minutes (e.g., Graf & Schacter, 1985) to 24 hours (Parkin et al., 1990). Several inconsistencies between the procedures used in the present experiment and those used by other investigators may serve to explain the discrepant results.

For example, those studies that observed reliable priming for sensible target words in sentences emphasized self-paced study of the sentences. Masson & MacLeod (1992, Experiment 8B) required subjects to form a mental image of the sentence and rate the difficulty of this imagery. Similarly, Parkin et al (1990) encouraged subjects not to rush through the sentences when judging their sensibility. This methodology stands in contrast to the present experiment where subjects were instructed to respond as quickly as possible while maintaining

accuracy on a semantic decision task. Perhaps the additional processing afforded by the self-paced tasks led to reliable levels of priming.

A similar account could serve to resolve differences in the results of Graf & Schacter (1985) and the present experiment. They required subjects elaborate on the meaning, or compare the number of vowels in each studied word-pair. They noted that on average subjects spent 8 seconds per word-pair on the elaboration task, and 5 seconds per pair on the vowel comparison task. This compares with approximately 1.5 seconds spent per word-pair by the young aged group, and almost 2 seconds per pair spent by the older age group performing the word-pair comparison task in the present experiment. Perhaps the extra time spent processing the word-pairs by subjects in Graf & Schacters' (1985) experiment produced reliable priming effects.

The second context manipulation, comparing performance across the three presentation contexts, revealed that priming did not reliably differ as a function of presentation context. For the sensible target words, priming was non-significant for the passage, sentence and word-pair conditions. Similarly, the nonsignificant priming by context interaction for nonsensible target words revealed that priming did not differ reliably across the three context conditions.

For non-sensible target words, the significant context by priming interaction for the passage and sentence contexts is suggestive of differences across some context conditions. While the analyses are statistically problematic (ie. post hoc comparison without an overall significant Context X Priming interaction), they

suggest potential differences. Unfortunately, I believe that the differences may reflect non-equivalence of item construction rather than differences among context conditions. As can be seen in appendices A and B, the non-sensible target words in the sentence context actually made the entire sentence non-sensible rather than solely the target word, as in the passage context. In this case it's almost like the target word is sensible in the sense that it blends into a non-sensible sentence.

Procedural differences between the passage and sentence contexts could have also contributed to the observed result. In the passage context, subjects processed the non-sensible items twice, first by finding the non-sensible sentence and second by rereading the sentence out loud to the experimenter. In the sentence context, the non-sensible word only required one reading before a decision could be made. Perhaps the additional processing afforded by rereading the sentence in the passage context contributed to the differences in priming between the two context conditions.

Age differences on Word Fragment Completion Priming.

The second question of interest was whether changes in study/test context influenced older and younger adults word fragment completion performance similarly. There were no reliable age differences in the priming of sensible and non-sensible target words in either of the three context conditions. This result contrasts with those reported by Hultsch et al. (1991) who found significant age differences on a stem completion task. This discrepancy may be a function of two

things. First, perhaps age differences are found with stem completion tests but not on word fragment completion tasks. The more likely reason for the discrepancy is that in order to detect significant age differences large sample sizes are typically needed (Hultsch et al., 1991). The small sample used in the present study may be insufficient to detect age differences in priming.

Additionally, the non-significant Age X Priming X Context interaction suggests that changes in context influenced both age groups similarly. This result stands in contrast to the earlier prediction that since older adults often process material less elaborately, maybe changes in context would be less disruptive to indirect test performance. This discrepancy could be a function of two things. Firstly, perhaps the deficits in elaborative processing often exhibited by older adults impair performance on direct tests of memory, but are not severe enough to disrupt performance on indirect tests of memory. This seems unlikely in the light of Simon's previous work (1979; Simon & Craik, cited in Craik & Simon, 1980) that found older adults less able to utilize contextual information and more reliant on phonemic structure to cue recall.

Alternatively, it may be the case that while older adults who exhibit deficits in elaborative processes would be less affected by context changes, the older adults in the present study are not sufficiently impaired relative to the younger adults. Evidence for the second point comes from the fact that older adults' performance did not differ from younger adults on three of the four cognitive tasks used in the present study. Older adults performed more poorly on only the

story recall measure. The absence of age differences in word similarities and working memory suggests perhaps older adults were not sufficiently impaired to produced differences in elaborative processes hence age did not mediate the influence of presentation context.

Limitations of the Present Study

Several aspects of the present research may limit its potential significance and generalizability of the results. The foremost problem is the lack of statistical power to detect small differences in performance. Assuming Cohen's (1988) definition of a small effect size, a power coefficient of .40 was calculated for the age effect, while the power to detect a context effect was only .30. It is likely that this lack of power may have contributed to the non-significant finding with respect to the context and age differences analyses for nonsensible target words where obvious mean level differences were present.

This problem with statistical power likely did not contribute to the finding of non-significant priming of sensible target words however, since priming levels were virtually zero in these instances. This suggests that inconsistencies between the present results and results of those who found significant levels of priming with sensible target words (e.g., MacLeod, 1989; Masson & MacLeod, 1992) cannot be simply ascribed to a lack of statistical power.

A second limitation is that different groups of words comprised the sensible and non-sensible target words. This prevented statistical comparisons of the priming that each group of words produced. It is also unclear whether the

present results would be comparable if all words were present in all conditions.

The final limitation deals with the absence of a direct test of memory for target words in the different context conditions. It was assumed that words that were presented in the passage context were processed more elaborately than those in the word-pair condition, but this assumption was never tested empirically. Similarly, older adults were expected to process the material less elaborately, but this was simply an assumption. Since performance on direct tests of memory benefit from elaborative processing, the inclusion of a direct test would have permitted testing of these assumptions.

Conclusion

It is evident that changes in an items' context influences indirect memory test performance in some instances, but not others. Words that fit in sensibly with the context did not produce priming, whereas words that did not fit in sensibly produced priming. On the other hand, changes in an items' context from passage to sentence or passage to word-pair had little influence on the magnitude of priming effects.

With respect to age differences, overall, older adults did not perform more poorly than younger adults on words fragment completion performance. Older adults were also similarly affected by changes in an items' context as compared to younger adults.

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Appendix A
Passages seen by subjects

1) Passages seen by even numbered subjects. Non-sensible portions are underlined, while target words are in capital letters.

Example 1
In Rome the first lessons taught were the use of the instrument and the simple chants of the religious service. As soon as the pupil knew how to play, the master taught him to render the works of the great lyric writers of Rome who were reared in the Space Shuttle.

Example 2
It is the specific purpose of this passage to attempt to estimate what America's fundamental ideas about international cooperation are likely to be, and to consider how far under the direct control of the woman's clubs they are likely to be compatible with the views and necessities of Europe.

ITEM 1
The American democracy depends for its EXISTENCE and success on the social consciousness and social cooperation of its citizens. Unless the school can make a significant contribution to the development of social consciousness and social cooperation among plants and PLANKTON, it must fail in one of its most important purposes.

ITEM 2
The life of a dry cell BATTERY is not fixed but depends on the circuit in which it is used. Oftentimes dry cells which are merely standing on the shelf for a year without being used at all will dry up because the RUTABAGA has not been watered and become practically useless.

ITEM 3
One of the most natural ways of thinking is that in which, as soon as one makes an ASSERTION, he recalls individual instances in which it has proved true; in other words, examples of the fact asserted. Therefore, this method of building up thought by using BEESWAX is common.

ITEM 4
Switzerland with ten million acres of mountains has cultivated rather efficiently the three and five-tenths percent that seemed worth

cultivating. She has been importing some food, but having little to EXCHANGE for food, excessive population increase among insects and DINOSAURS on the products of other soils was denied here.

ITEM 5
Much of the Old testament written in Semitic dialect is POETRY to compare with the Homeric words, which are in the Indo-European dialects. It further contains an account of the Hebrews and their relations with other states, an exact duplicate of a PIMENTO and a system of ritual.

ITEM 6
Until the world learns what it means to pull together with other people, we shall never have the realization of the real PATRIOT. And we will never learn to pull together as long as we are taught that one of us who eats a CUPCAKE is worth half a dozen others.

ITEM 7
During the last two decades the methods of teaching in our schools have changed rapidly and profoundly. The critics of our schools think that our newer methods give children too much FREEDOM, and especially that they substitute the use of the hand which should be sprinkled with CINNAMON for the exercise of the brain.

ITEM 8
The life AMBITION of Emma Hart Willard was to organize a system of education for women which should possess the same permanency, uniformity and respectability as educational institutions for men, and yet should so differ as to be adapted under the BEHAVIOUR of Julius Caesar to the needs of women.

ITEM 9
The man who succeeds must think, and the man who thinks must get his thought clear in his own mind. To define his thought clearly to himself, he must put it accurately into words-LANGUAGE. To communicate accurately, he must learn what words, which are found at the end of the RAINBOW, mean.

ITEM 10
It happened in the eighteenth century that there were several remarkably intelligent MONARCHS-Frederick II of Prussia, Catherine the Great of Russia, Charles III of Spain, Emperor Joseph II and his brother Leopold, Grand Duke of the UNIVERSE. These rulers read the works of the reformers and planned many reforms for bettering existing

conditions.

ITEM 11
The term "EXECUTIVE" is used to designate those officers of the government whose business it is to carry out the law of the land. In the narrower sense it often signifies merely the supreme head of the administration who always serves as a SURGEON, or the same person together with his chief subordinates.

ITEM 12
A simple and convenient starting point may be found in the STATEMENT that political science deals with government. The word "government" used in its widest sense, rests on the fundamental idea of control and obedience; it implies authority of the National YOGHURT Company, and a submission to that authority.

ITEM 13
Jefferson was the most finished scholar of Revolutionary times, and he was always interested in education. He spent the later years of his life trying to improve the schools of Virginia which occurred during an ELLIPSE, and helping to establish the UNIVERSITY of Virginia.

ITEM 14
The older the school pupil becomes, the stronger is the force of those ECONOMIC and social influences which ultimately will remove him from the school. Up to the age of fourteen the public schools hold the pupils well aided by the compulsory attendance laws under the guidance of the AARDVARK.

2) Passages seen by even numbered subjects

Example 1
Switzerland with ten million acres of mountains has cultivated rather efficiently the three and five-tenths percent that seemed worth cultivating. She has been importing some food, but having little to trade for food, excessive population increase among insects and penguins on the products of other soils was denied her.

Example 2
A simple and convenient starting point may be found in the belief that political science deals with government. The word "government" used in its widest sense, rests on the fundamental idea of control and obedience; it implies authority of the National Grape Company, and a submission to that authority.

ITEM 1
It is generally held among HISTORIANS that the first appearance of our cultural ancestors upon the soil of Western Europe occurred about 2000 B.C. At that time a group of tribes, admitting kinship to common origin, came down out of the grassland of central Asia by TRICYCLE and overran the peninsula.

ITEM 2
With the WIDESPREAD extension of good roads has come a very rapid growth of transportation by motor trucks and motor buses which usually pay only a small license fee for the right to wear FLANNEL pajamas, and which derive profit from the carrying of freight and passengers.

ITEM 3
Rome's institutions as she developed them remained those of a city. It was very difficult to apply them to the vast TERRITORY she attempted to govern with their aid. They were clumsy institutions which functioned irregularly and proved a system for the construction of TOBOGGANS that could not and did not last.

ITEM 4
Prolonged studies of the origin of very gifted children in this country have been confined to large cities. They have shown repeatedly that the great MAJORITY of these children originated in families where the father is a professional man, a CHIMNEY sweep, or an owner or executive in business.

ITEM 5
Early types of vocational education were especially strong in the practical aspects of the subject and weak in the more ABSTRACT phases. The home, farm and shop have always provided an abundance of practical tasks and examples whereby to teach boys and girls who were fond of BROCCOLI the simple vocational arts.

ITEM 6
In ANCIENT Greece the first lessons taught were the use of the instrument and the simple chants of the religious service. As soon as the pupil knew how to play, the master taught him to render the works of the great lyric writers of Greece who were reared in the TWILIGHT zone.

ITEM 7
Constant pressure is being put upon pupils to continue in

school for full time after completing the elementary school curriculum. With a view to facilitating the TRANSITION from the elementary to the high school, the junior high school which is adapted to the LADYBUG is being widely established.

ITEM 8
The key to any analysis of aims in education is to be found in an analysis of the activities of life in which people should or do engage. The aim of secondary education, therefore, must be interpreted in terms of the activities in which individuals with INSOMNIA PARTICIPATE.

ITEM 9
During the unprecedented SCIENTIFIC development of the past half century, there have frequently arisen certain technical tendencies on the part of researchers which have caused many other persons to misunderstand the real nature of truth which is found in BACHELORS and old maids.

ITEM 10
It is the specific purpose of this ARTICLE to attempt to estimate what America's fundamental ideas about international cooperation are likely to be, and to consider how far under the direct IDEOLOGY of the women's clubs they are likely to be compatible with the views and necessities of Europe.

ITEM 11
When commerce advanced, industry did not stand still. To satisfy the demands of a growing number of customers all over the world, production must be increased. But that could not be done without changes in both the method of MANUFACTURE which depended on the COCONUT crop and its organization.

ITEM 12
Notwithstanding Spanish indifference and monastic opposition, the Filipinos have opened elementary schools in almost every village. They have also founded high schools and COLLEGES throughout the archipelago, and two large normal schools for janitors and POLLIWOGS, and five large schools for women in Manila.

ITEM 13
The English colonies of the Atlantic SEABOARD, occupied with their own problems of developing agricultural resources, build-

ing up their commerce, defending their precious rights of self-government against king and proprietor, were slow to realize the serious meaning of the French power generated by KEROSENE which was gradually surrounding them.

ITEM 14
Recent studies have shown that feeble-mindedness is one of the important causes of permanent delinquency. Goddard has shown the mental defect is hereditary in perhaps sixty-five to seventy-five percent of the cases. If his estimate is correct, feeble-mindedness which results from GANGRENE is largely a HEREDITARY factor.

Appendix B

Sentences Seen by Odd Numbered Subjects*

EXAMPLE A
The tree fell with a loud crash.

EXAMPLE B
She bought two thousand pounds of fish at the supermarket.

EXAMPLE C
The water in the kettle was boiling so the woman made a pot of tea.

EXAMPLE D
The baby was exhausted after reading the long novel.

ITEM 1
The MAJORITY of the public agreed with the decision.

ITEM 2
The dog was near the library when he decided to borrow a book on horses.

ITEM 3
It took three months to get an appointment with the doctor.

ITEM 4
The HISTORIAN translated the tattered manuscript.

ITEM 5
Her pet POLLIWOG was fluent in at least three different languages.

ITEM 6
The plane crashed into the sea when it landed at the airport.

ITEM 7
She heated the bran muffin in the microwave oven when she got home.

ITEM 8
The radio announcer showed his listeners a brick CHIMNEY.

ITEM 9
She often watched the large ships as they transported goods up and down the SEABOARD.

ITEM 10
Every July she goes on a winter vacation to visit her family in Ontario.

ITEM 11
The exam had twenty multiple choice and three long essay questions

ITEM 12
The swim club assembled daily at the local pool.

ITEM 13
The doctors questioned whether the disease was HEREDITARY.

ITEM 14
After the wedding the groom announced that he was proud to be a BACHELOR.

ITEM 15
They both enjoyed the TWILIGHT sky in the middle of the afternoon.

ITEM 16
The woman bought a new typewriter ribbon at the stationary store yesterday.

ITEM 17
The soccer players found it easier to win the game while wearing skates.

ITEM 18
The North West TERRITORY is a land of great beauty and splendor.

ITEM 19
The picnic that was planned for the afternoon was canceled due to bad weather.

ITEM 20
Tons of steel are required to MANUFACTURE a large ship.

ITEM 21
She was lying on the beach in the winter and got a lovely suntan.

ITEM 22
She questioned the teacher when he said there would be no tests.

ITEM 23
The map of the country was hanging on the wall of the classroom.

ITEM 24
The children went singing Christmas carols during the summer holidays.

ITEM 25
The fire was brought under control by spraying it with KEROSENE.

ITEM 26
The fashion magazine featured a very interesting ARTICLE.

ITEM 27
The COLLEGE students celebrated the end of classes at a local pub.

ITEM 28
Each pair of numbers consisted of three and four letters.

ITEM 29
The piece of BROCCOLI was purple and weighed several hundred tons.

ITEM 30
The school children were mainly adult men and women.

ITEM 31
He drank the beer out of a mug which his mother had given him for his birthday.

ITEM 32
She slept all night because she had INSOMNIA.

ITEM 33
The woman received a large package in the mail.

ITEM 34
He didn't like the painting because it was too ABSTRACT.

ITEM 35
The clerk at the plant shop sold many flowers and bags of soil.

ITEM 36
The scuba diver had done a great deal of deep sea diving in the shallow pool.

ITEM 37
The waiter received thirty COCONUTS in tips every night so he could afford a new car.

ITEM 38
The killers' IDEOLOGY was to be kind to all human beings.

ITEM 39
The destruction from the hurricane was WIDESPREAD.

ITEM 40
The cast iron frying pan was as light as a thin piece of paper.

ITEM 41
The ambulance drivers helped the victim by giving him GANGRENE.

ITEM 42
She played the piano for all of her relatives at the party.

ITEM 43
The LADYBUG in the tree played a guitar and sang all night.

ITEM 44
They went to the museum to see the ANCIENT artifacts.

ITEM 45
The newlywed couple celebrated their twentieth anniversary last year.

ITEM 46
The FLANNEL shirt fell to the floor and crashed into many tiny pieces.

ITEM 47
It was cold and rainy on the bright sunny day.

ITEM 48
The students made the difficult TRANSITION from Junior to High School.

ITEM 49
The man with the broken back beat the record for running a two minute mile.

ITEM 50
Tables and chairs of wood construction seem more sturdy than those made of plastic.

ITEM 51
The SCIENTIFIC community was amazed at the discovery.

ITEM 52
The family moved all their possessions into their new house.

ITEM 53

The family brought the TOBOGGAN to the beach to go sailing.

ITEM 54
The TRICYCLE was tossed and turned on the tiny waves as it crossed the desert.

ITEM 55
The teacher tried to get all of the students to PARTICIPATE in the activity.

ITEM 56
He worked at the office for nine days last week.

Sentences Seen by Even Numbered Subjects

EXAMPLE A
The tree fell with a loud crash.

EXAMPLE B
She bought two thousand pounds of fish at the supermarket.

EXAMPLE C
The water in the kettle was boiling so the woman made a pot of tea.

EXAMPLE D
The baby was exhausted after reading the long novel.

ITEM 1
Favourable EXCHANGE rates enticed more Canadians to vacation in the United States.

ITEM 2
The dog was near the library when he decided to borrow a book on horses.

ITEM 3
It took three months to get an appointment with the doctor.

ITEM 4
The couple went to see the FOREIGN language film at the cinema.

ITEM 5
She ironed the RUTABAGA before she put it into the washing machine.

ITEM 6
The plane crashed into the sea when it landed at the airport.

ITEM 7
She heated the bran muffin in the microwave oven when she got home.

ITEM 8
The man ate the YOGHURT by spreading on his feet.

ITEM 9
The countries ECONOMIC forecast did not look good.

ITEM 10
Every July she goes on a winter vacation to visit her family in Ontario.

ITEM 11
The exam had twenty multiple choice and three long essay questions.

ITEM 12
The swim club assembled daily at the local pool.

ITEM 13
Her ASSERTION made it clear that she meant what she was talking about.

ITEM 14
The ELLIPSE at the zoo was fed promptly at noon.

ITEM 15
The crowd cheered Brian Mulroney, master of the UNIVERSE.

ITEM 16
The woman bought a new typewriter ribbon at the stationary store yesterday.

ITEM 17
The soccer players found it easier to win the game while wearing skates.

ITEM 18
Her AMBITION was to become a world renown concert pianist.

ITEM 19
The picnic that was planned for the afternoon was canceled due to bad weather.

ITEM 20
The very EXISTENCE of such a beautiful setting astonished them.

ITEM 21
She was lying on the beach in the winter and got a lovely suntan.

ITEM 22
She questioned the teacher when he said there would be no tests.

ITEM 23
The map of the country was hanging on the wall of the classroom.

ITEM 24
The children went singing Christmas carols during the summer holidays.

ITEM 25
The DINOSAUR scored a goal in the last few minutes of the game.

ITEM 26
Some UNIVERSITY students were lucky to find summer jobs.

ITEM 27
The EXECUTIVE left the office at noon for lunch.

ITEM 28
Each pair of numbers consisted of three and four letters.

ITEM 29
The movie star won a eight ton CUPCAKE at the awards ceremony.

ITEM 30
The school children were mainly adult men and women.

ITEM 31
He drank the beer out of a mug which his mother had given him for his birthday.

ITEM 32
The PIMENTO was picked from the apple tree in the orchard.

ITEM 33
The woman received a large package in the mail.

ITEM 34
His bank STATEMENT showed that he was overdrawn by one hundred dollars.

ITEM 35
The clerk at the plant shop sold many flowers and bags of soil.

ITEM 36

The scuba diver had done a great deal of deep sea diving in the shallow pool.

ITEM 37
The PLANKTON she was holding thoroughly enjoyed the walk through the park.

ITEM 38
The AARDVARK had a litter of ten kittens this morning.

ITEM 39
The hostages were anxious for their FREEDOM.

ITEM 40
The cast iron frying pan was as light as a thin piece of paper.

ITEM 41
At midnight the whole town came turned out to see the RAINBOW.

ITEM 42
She played the piano for all of her relatives at the party.

ITEM 43
As a SURGEON, her job is to bake and slice bread.

ITEM 44
The MONARCH addressed the large crowd which cheered wildly.

ITEM 45
The newlywed couple celebrated their twentieth anniversary last year.

ITEM 46
The cat climbed the fir tree and stole the BEESWAX from the bird's nest.

ITEM 47
It was cold and rainy on the bright sunny day.

ITEM 48
The PATRIOT proudly displayed his Canadian flag.

ITEM 49
The man with the broken back beat the record for running a two minute mile.

ITEM 50
Tables and chairs of wood construction seem more sturdy than those made of plastic.

ITEM 51
The POETRY reading was very well attended.

ITEM 52
The family moved all their possessions into their new house.

ITEM 53
Her parents scolded the BEHAVIOUR, she had done nothing wrong all day.

ITEM 54
The pot of CINNAMON was so hot it froze his lips.

ITEM 55
His digital watch flickered because it needed a new BATTERY.

ITEM 56
He worked at the office for nine days last week.

* Target words are printed in capital letters.

Appendix C

Word-Pairs Seen by Odd Numbered Subjects

MANUFACTURE - goods

spirit - foither

GANGRENE - encome

large - company

pappern - KEROSENE

POLLIWOG - offace

foople - dwingal

siries - trees

difficult - TRANSITION

sulport - COCONUT

degree - teath

free - trade

ANCIENT - greece

TOBOGGAN - seltion

windal - truth

leater - record

vast - MAJORITY

WIDESPREAD - belief

mother - father

surface - sciense

bleck - yeeps

radio -show

eastern - SEABOARD

points - trian

leading - ARTICLE

good - value

COLLEGE - sport

unian - hours

help - PARTICIPATE

ground - water

HEREDITARY - disease

parket - example

IDEOLOGY - repert

island - nabion

ABSTRACT - painting

broken - heart

velume - husband

resigert - jamck

ranje - FLANNEL

TRICYCLE - persol

morning - dew

open - space

manth - BROCCOLI

true - north

pross - CHIMNEY

street - sign

TWILIGHT - seption

northern - TERRITORY

music - foither

SCIENTIFIC - instrument

calmih - manurt

forpe - effort

horse - carriage

INSOMNIA - niture

sewing - machine

famous - HISTORIAN

plant - dictor

sammer - LADYBUG

weefs - BACHELOR

party - hat

Word-Pairs Seen by Even Numbered Subjects

ECONOMIC - growth

spirit - foither

pappern - RAINBOW

large - company

UNIVERSE - office

PIMENTO - sulport

foople - dwingal

siries - trees

strong - ASSERTION

seltion - AARDVARK

degree - teath

free - trade

UNIVERSITY - campus

repert - PLANKTON

windal - truth

leater - record

FOREIGN - exchange

FREEDOM - reigns

mother - father

surface - sciense

bleck - yeeps

radio - show

english - LANGUAGE

pjonts - train

royal - MONARCH

good - value

BATTERY - acid

unian - hours

blind - AMBITION

ground - water

EXECUTIVE - committee

parket - example

ranje - BEESWAX

island - nabion

STATEMENT - date

broken - heart

velume - husband

resigert - jamck

SURGEON - persol

manth - YOGHURT

morning - dew

open - space

pross - CINNAMON

true - north

ELLIPSE - seption

street - sign

CUPCAKE - niture

romantic - POETRY

music - foither

PATRIOT - colors

calmih - manurt

forpe - effort

horse - carriage

weefs - DINOSAUR

sewing - machine

happy - EXISTENCE

plant - dictor

RUTABAGA - encome

BEHAVIOUR - sammer

party -hat

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Publications

Hultsch, D.F., Masson, M.E.J., & Small, B.J. (1991). Adult age differences in direct and indirect tests of memory. Journal of Gerontology: Psychological Sciences, 46, p22-30.

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Title of Thesis: ADULT AGE DIFFERENCES IN WORD FRAGMENT COMPLETION PRIMING AS A FUNCTION OF PRESENTATION CONTEXT.

[redacted]

BRENT JOHN SMALL

Sept 10, 1992

Date