Processing and Generation Effects on Explicit & Implicit Memory Performance in Younger and Older Adults

by

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Abstract

PROCESSING AND GENERATION EFFECTS
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Adviser: Wilma A. Winnick, Ph.D.

Younger and older adults were compared in 2 levels of processing experiments. The experiments varied in the use of the standard levels of processing paradigm and a novel elaboratively encoded levels of processing paradigm. In Experiment 1 subjects performed standard yes/no perceptual and conceptual encoding tasks and were then administered Recognition and Word Fragment Completion Tests. Experiment 1 was considered the baseline experiment to determine if the levels of processing effect, as well as previously found memory performance differences between younger and older adults, would be replicated. In Experiment 2, perceptual and conceptual encoding tasks calling for active generation were introduced. The requirements were to generate either a sentence or five words beginning with the same letter as the target word. It was predicted that the elaborative encoding required in both the perceptual and conceptual study tasks would reduce any group differences found in Experiment 1.

With the standard levels of processing task of Experiment 1, younger adults obtained higher explicit memory scores and there was a suggestion that they benefited more from conceptual encoding than older. In contrast, with an active, generative encoding task, older adults' memory performance was on the same level as younger and the implication of a conceptual processing benefit for younger adults was no longer present. The active, generational study task equated the older adults' memory performance with the younger on the implicit memory test as well, but in this case the hint of a conceptual processing benefit remained.

Findings support Craik's (1984) production deficiency hypothesis of age-related memory decrements that would predict differences between the groups with a standard levels of processing task and a reduction in group differences with a more active processing task when the production deficiency is eliminated. Results are also consistent with Moscovitch's (1989) working-with-memory model suggesting that increased encoding activation, and concomitant putative frontal lobe involvement in the memory process, improves the memory performance of older adults.

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Introduction

This study has examined the effects of an effortful, elaboratively encoded processing task compared to effects of standard levels of processing tasks on the explicit and implicit memory performance of younger and older adults.

Numerous studies have documented larger age-related decrements in explicit than implicit memory test performance (see Howard, 1988; Light, 1988, for reviews). There are two distinct interpretations that might account for these differences. One is that there are two separate memory systems, one affected by aging and one not (Light & Singh, 1987). Another is that differences may be due to reduced processing resources as a function of age (Craik, 1984). Craik states that effortful elaborative processing is less likely to occur spontaneously in older adults and therefore contributes to age-related memory differences. Additionally, according to Craik, memory is best understood in terms of the interaction of encoding and retrieval processes, and efficient mental operations will be performed when they are induced and guided by the task, by specific instructions, or by other supportive aspects of the environment.

This two-experiment study of memory performance in healthy younger and older persons has made use of two distinctive encoding paradigms at the study or input stage. Differences in memory performance as a function of age were expected from each of the paradigms, but, as the paragraph below explains, more complicated predictions were called for in comparisons of effects of age across the second of the two paradigms.

The paradigm used in the first experiment presented encoding questions about each word requiring only Yes/No (Y/N) responses; this is the standard levels of processing (LOP; Craik & Lockhart, 1972) manipulation. One question was perceptually based (Are there any "e's" in the word?) and the other semantically based (Does the word denote something alive?). Craik and Lockhart's view is that semantically-based questions produce deeper neural traces and hence will bring about superior memory performance compared to those that are perceptually based. It was expected that these findings would be substantiated for younger and older adults. It was also expected that younger adults would obtain higher explicit memory scores than older following the non-elaborative processing required by this encoding task.

The second experiment paralleled the first, but used a paradigm calling for greater cognitive activation than required by the yes/no questions of Experiment 1. The cognitive activation was of the variety that has been studied in experiments on the generation effect where the participant is asked to produce (or generate) target material, as when one word of a strongly linked word pair is given (e.g., HOT- ______) or when a sentence is presented with the last word omitted and to be generated (e.g., The children filed out of the room at the sound of the fire ________) (Slamecka & Graf, 1978).

Novel in this experiment was the introduction of a processing paradigm requiring generative rather than yes/no responses while maintaining the perceptual and conceptual encoding conditions of Experiment 1. The conceptual required generation of a sentence including the target word, and the perceptual called for naming five words beginning with the same initial letter as the target word. Thus, generation of two kinds was introduced here as a novel form of processing and one that does not clearly fit into the hierarchy implied in the levels of processing framework.

It was predicted that both processing instructions, evoking active forms of processing, would produce higher scores compared to Experiment 1 and that aging persons might, on the memory tests used, show a greater proportional benefit than younger. The first prediction was based on the robust findings from the many generation experiments sparked by the original study, and identification of, the generation phenomenon by Slamecka and Graf (1978). The second was based on Craik's view of reduced effortful elaborative processing in aging (1984) and the beneficial effect that guided, active encoding might have on older adults' memory performance (Rabinowitz, 1989). One goal of this dissertation was to determine whether the findings were consistent with Craik's (1984) view and whether induced cognitive activation would improve older adults' memory performance.

That older and younger persons might show memory performance differences whose magnitudes differed as a function of the explicit/implicit memory tests used seemed a strong possibility in light of the research summarized by Schacter (1987) in which it was found that older persons are likely to have significant losses on explicit tests but much less of a loss on implicit. Schacter has stated that although several studies have reported that older adults show intact repetition priming (Graf & Schacter, 1985; Light, Singh, & Capps, 1986), little else is known about the relation between aging and implicit memory. With the aim of trying to improve understanding about aging, encoding processes and implicit memory, two kinds of memory tests were used in this study, one explicit (recognition) and one implicit (word fragment completion).

The preceding material has touched on three areas of relevance to this study of memory performance in younger and older persons: levels of processing, the generation effect, and explicit/implicit memory tasks. Research on each of these topics will now be summarized.

Encoding and Retrieval in Memory Performance: The Levels of Processing View and Young/Old Comparisons

In 1972, Craik and Lockhart proposed levels of processing as an "alternative framework" (p. 671) for earlier formulations of memory that had focused on three distinct memory stores, the sensory register, short-term store (STS), and long-term store (LTM), and the transfer of information among them. Craik and Lockhart's view was that the empirical evidence in support of the multistore model was inadequate. They suggested a theory in which perceptual encoding was seen as:

> a series or hierarchy of processing stages...referred to as [depth of processing] where greater [depth] implies a greater degree of semantic or cognitive analysis....Analysis proceeds through a series of sensory stages to levels associated with matching or pattern recognition and finally to semantic-associative stages of stimulus enrichment (Craik & Lockhart, 1972, p. 675).

In a standard levels of processing experiment the levels are operationally specified by the questions asked. The structural or perceptual level asks whether the word contains a particular vowel or consonant, or asks about other physical features of the word. Concentration on such surface physical properties results in poor recall scores on a subsequent test. In contrast, a "deeper" or "more elaborative" level asks questions requiring semantic analyses, and concentration on meaning, results in higher levels of recall. In experiments that compare perceptual and conceptual processing effects on memory, the levels of processing is said to occur when memory scores are higher after a word has been processed conceptually rather than perceptually.

In 1975, Craik and Tulving analyzed the levels of processing framework in explicit memory performance in a series of 10 experiments. Their findings confirmed that depth of processing affects explicit memory; deeper levels of processing result in higher scores on recall and recognition tests. Four types of encoding questions were asked: 1) about the physical structure of the word (a surface level of analysis) (e.g., "Is the word printed in capital letters?"); 2) about the word's rhyming characteristics (e.g., "Does the word rhyme with TRAIN?"), considered a phonemic level of analysis; and 3) either categorical (e.g., "Is the word an animal name?") or 4) sentence questions (e.g., "Would the word fit the following sentence: 'The girl placed the __________ on the table'?"), considered semantic levels of analysis. The results showed that semantic, as opposed to structural, decisions about words require slightly longer processing times and result in significantly higher recognition and recall scores. They further showed that the encoding operation and not the amount of time spent in analysis was crucial for retention (Craik & Tulving, 1975, p. 289).

Other studies of the levels of processing effect have obtained findings consistent with those of Craik and Tulving (Graf & Mandler, 1984; Jacoby & Dallas, 1981). Both cited studies found a significant effect of levels of processing on explicit memory performance and no such effect for implicit memory performance. The Jacoby and Dallas study (1981) was one of the earliest to report a dissociation between explicit and implicit memory performance in normal subjects. These findings extend to older adults (Light & Singh, 1987; Java & Gardiner, 1991; Park & Shaw, 1992). Thus the levels of processing variable, requiring differences in encoding, suggests itself as an important variable in studies of age differences in memory.

Light and Singh (1987) studied younger (range = 19-32 years) and older (range = 60-76 years) adults for whom two levels of processing were used at encoding. Subjects studied a list of words accompanied by either 1) a vowel comparison condition (in which subjects indicated whether successive words on the list shared any vowels) or 2) a pleasantness rating condition (in which subjects rated the pleasantness of each word on a 7-point scale). A free recall test, a two-alternative forced-choice recognition test, and a word stem completion test were then given. There was a significant effect of levels of processing on the explicit tests (free recall and two-alternative forced-choice recognition); for both younger and older adults, explicit memory test performance was higher in the semantic compared to the non-semantic condition. In contrast, there was no effect of encoding condition on the implicit test in either group. There was also a significant interaction between study task and age for both recognition and recall tests. Although both groups obtained higher explicit memory scores in the semantic than in the nonsemantic encoding condition, younger adults benefited more from semantic encoding than did older.

Such a dissociation, in which explicit but not implicit memory performance is affected by levels of processing, is a general finding in the literature (e.g., Java & Gardiner, 1991; Java, 1992; Light, LaVoie, Valencia-Laver, Owens, & Mead, 1992; Park & Shaw, 1992), that is, conceptual processing results in better explicit memory performance than does perceptual processing. Additionally, in certain studies (Light & Singh, 1987; Park & Shaw, 1992), younger adults have benefited more than older adults from conceptual processing on explicit tests, although not on implicit memory tests. However, Brown and Mitchell's recent meta-analysis (1994) reports frequent occurrences of the levels of processing effect on implicit memory.

Contrary to these general, often-cited results, there have been studies of older versus younger adults that have found an effect of encoding condition on implicit memory (Chiarello & Hoyer, 1988; Davis, Cohen, Gandy, Colombo, VanDusseldorp, Simolke, & Romano, 1990; Hultsch, Masson, & Small, 1991).

In Chiarello and Hoyer's study (1988), younger (range = 18-22 years) and older (range = 57-75 years) subjects were administered either a vowel judgment task (read the presented word aloud and then state whether the presented word shares vowels with the immediately preceding word) or a pleasantness judgment task (read the presented word aloud and then state whether the word seems pleasant, neutral, or unpleasant). Either a word stem completion (implicit) test or a cued-recall (explicit) test were then given at each of three different delays (0, 13, and 46 minutes). There were main effects of age, encoding, and delay: Younger persons had higher memory scores than older; memory was better for pleasantness than for vowel encoding; and memory showed a significant decline only over the first 13 minutes. Additionally, the encoding task and memory test produced an interaction with memory performance significantly better after the pleasantness judgment task than after the vowel judgment task for both word completion and cued recall for both groups. With the aim of replication, the present study analyzed the effect of a similar levels of processing study task on explicit and implicit memory test performance.

A study by Hamberger and Friedman (1992) showed an electrophysiological effect of levels of processing in older adults similar to that found in young and middle-aged adults. Three groups (young = mean age 24.94 years, middle-aged = mean age 48.86 years, and older = mean age 70.11 years) were presented with two blocks of orthographic (uppercase vs. lowercase words) and two blocks of semantic (animal vs. non-animal words) stimuli. Each block consisted of 108 words: One third were new and did not repeat; one third were new and did repeat at lags of 2, 8, and 32 intervening items following initial presentation; and one third were old. Subjects made speeded, "choice" responses to the animal vs. non-animal words in the semantic blocks, and to the uppercase vs. lowercase words in the orthographic blocks by pressing either a right- or left hand-held button while EEG was recorded. Although the study showed behavioral evidence of repetition priming in faster reaction times to repeated items in both tasks, ERP amplitude was responsive to repetition only when a semantic discrimination was required. The results were similar across age groups. This is electrophysiological evidence of a distinct neural event occurring during one type of processing (semantic) and not during another type of processing (orthographic) on an implicit memory test.

This review of the literature has found little agreement on the effect of levels of processing on explicit and implicit memory in either younger or older adults. It is not clear whether conceptual processing affects the explicit memory performance in younger adults to a greater degree than it does in older adults or whether conceptual processing affects the implicit memory performance of younger and older adults in the same way. Two recent meta-analyses (Brown & Mitchell, 1994; La Voie & Light, 1994) provide a partial answer regarding implicit memory. Brown and Mitchell concluded that levels of processing affects the implicit memory performance of both younger adults and healthy older adults, and La Voie and Light concluded that there is an age difference in the extent of repetition priming for verbal materials that does not vary across response measures (accuracy vs. latency), types of priming (item vs. associative), or experimental paradigms.

Hamann and Squire (1996) attributed the levels of processing effect found in implicit memory tests to the influence of unintentional explicit retrieval as it carries over to influence implicit tasks. In addition, other variables such as test awareness (Bowers & Schacter, 1990); between- versus within-groups experimental designs, and the manipulation of levels of processing in which a blocked or random presentation was used (Challis & Brodbeck, 1992); and the presence or absence of a prior free recall test (Graf, Squire, & Mandler, 1984) have been reported to be related to the levels of processing effect.

In 1972, Craik and Lockhart expressed the view that experimental analyses must acknowledge the effect of retrieval processes on memory performance rather than focusing on encoding processes only: "We have looked at memory purely from the input or encoding end; no attempt has been made to specify...how items are retrieved from the system" (p. 682). Since then, the retrieval aspect of memory has been incorporated into explicit and implicit memory research. According to Craik: "Encoding is...the set of processes involved in the perception and interpretation of the original event and retrieval is the attempted recapitulation of the original pattern of encoding activity" (1994, p. 156). With the added feature of overlap between encoding and retrieval activities, this account is similar to those of transfer-appropriate processing (Morris, Bransford, & Franks, 1977), encoding specificity (Tulving & Thomson, 1973), and the processing account (Blaxton, 1989; Roediger & Blaxton, 1987; Roediger, Weldon, & Challis, 1989). Greatest attention has been paid to retrieval differences in explicit and implicit tasks.

Jacoby (1983) developed a data-driven (perceptual) processing versus conceptually driven processing distinction to explain dissociations between performance on explicit and implicit memory tests. He concluded that "...the cues provided for retrieval by a test, or the operations employed to process an item during a test, must be compatible with the prior processing of that item for evidence of memory to be obtained" (p. 503).

A study condition that involves data-driven processing is one that requires analysis of the physical features of a target word (similar to Craik's shallow levels of processing encoding task) rather than its semantic features. The subject's memory performance is predicted to be better if the test recapitulates the data-driven processing evoked at study. Similarly, a study condition that involves conceptually driven processing (in which the subject analyzes the semantic features of a target word - similar to Craik's deep levels of processing encoding task) will result in better memory performance on a test that recapitulates the conceptually driven processing performed at study.

Initially, implicit tests were considered synonymous with data-driven processing tests (e.g., perceptual identification, lexical decision, word-stem completion, word-fragment completion); and likewise, explicit and conceptually driven processing tests (e.g., free recall, cued-recall, and recognition) were hypothesized to be identical. Subsequent to the Jacoby (1983) study, however, an important distinction was made regarding data-driven and conceptually driven processing (Blaxton, 1989; Roediger & Blaxton, 1987; Roediger, Srinivas, & Weldon, 1989) and their relation to explicit and implicit memory tests. Rather than viewing the processing component at study as identical to the type of test, as had been the case, Roediger & Blaxton (1987) and Blaxton (1989) hypothesized that four memory tests be compared rather than two: data-driven explicit tests, conceptually driven explicit tests, data-driven implicit tests, and conceptually driven implicit tests. Blaxton stated: "Dissociations among memory tasks are better explained in terms of degree of overlap between mental operations at study and test than in terms of various memory systems underlying different tasks" (1989, p. 657). This research has led to the recognition that type of processing is not the same as type of task.

The work of Blaxton (1989), Roediger & Blaxton (1987), and Roediger, Srinivas, & Weldon (1989) strongly suggests that the data driven (implicit) versus conceptually driven (explicit) dichotomy is best viewed as a continuum. The rationale is that although there may be tests that are completely data-driven or conceptually driven (endpoints of the continuum), there are tests that contain both data-driven and conceptually driven processing components, with each type of processing component affecting the test results, in varying degrees. This view has led to a reevaluation of the effects of perceptual and conceptual processing on implicit memory tests. Several researchers concluded that conceptually driven processing had an effect on explicit tests and conceptually driven implicit tests, such as a general knowledge test (Blaxton, 1989; Hamann, 1990; Srinivas & Roediger, 1990).

Implicit tests that had been considered completely data driven have been examined (e.g., word stem and word fragment completion) for conceptual processing components (Fleischman, Gabrieli, Reminger, Rinaldi, Morrell, & Wilson, 1995; Hirshman, Snodgrass, Mindes, & Feenan, 1990; Keane, Gabrieli, Fennema, Growdon, & Corkin, 1991; Weldon, 1991). These studies have suggested a conceptual processing component in certain data-driven implicit tests. The Word Fragment Completion Test has been extensively analyzed in normal young adults and has been shown to be affected by conceptually driven processing (Challis & Brodbeck, 1992; Hirshman et al. 1990; Weldon, 1991, 1993). According to Weldon, word fragment completion is more sensitive than perceptual identification to conceptual factors, strengthening the notion that data-driven tests can be ordered on a continuum that reflects the relative contribution of conceptually driven encoding processes.

Challis and Brodbeck (1992) studied the levels of processing encoding variable in an analysis of perceptual and conceptual processing in word fragment completion in normal young adults and showed an effect of levels of processing on this data-driven implicit test. Whether the levels of processing variable was manipulated between subjects or within subjects in a blocked fashion, significant levels of processing effects were obtained: Higher implicit memory scores were obtained for words that were semantically processed. (Similar results with blocked materials have been obtained elsewhere. See Java, 1992, and Java & Gardiner, 1991.)

Challis and Brodbeck (1992) surveyed the literature for levels of processing effects in data-driven implicit tests and found significant effects in two studies that had used the Word Fragment Completion Test (Squire, Shimamura, & Graf, 1987, Experiment 3; Srinivas & Roediger, 1990, Experiment 2). Based on this and on their own findings, they concluded that levels of processing affects priming in perceptual tests, despite previous claims to the contrary.

Weldon (1993) analyzed the time course of the perceptual and conceptual components of the Word Fragment Completion Test. Types of prime and word fragment exposure time were varied, with only one of the primes - visual words - producing a superior result. The question of whether the superior result with visual words was due to the quick buildup of perceptual processes or simply that visual words lead to better performance overall was explored in this experiment by manipulating the levels of processing at encoding. Subjects performed either a shallow or a deep encoding task with the same prime types used in the first experiment (visual word, auditory word, or picture). Several higher-order significant interactions were found, including a three-way interaction of prime type, interval, and levels of processing. According to Weldon, the results:

> suggest three properties of priming on the word fragment completion test. First, perceptually similar primes (visual words) produce more priming than conceptually similar but perceptually dissimilar primes. Second, perceptual information becomes available sooner than conceptually relevant information. Third, the perceptual information is resolved at a faster rate than other word-level or conceptual information (p. 1019).

This is the only study that has analyzed the mechanisms of priming utilizing the response deadline (i.e., time limit) and response latency paradigms. No other data-driven implicit test (e.g., word stem completion) has been similarly examined to date.

As seen above, perceptual and conceptual processing are clearly involved at encoding and retrieval. How they affect the memory performance of younger and older adults was the focus of this study.

<u>Generation as Processing and Young/Old Comparisons</u>

The generation effect (Slamecka & Graf, 1978) refers to the advantage - in terms of later recall or recognition performance - of generating rather than reading information in the study phase of a learning task (Richardson-Klavehn & Bjork, 1988). The view has been expressed that generation is a type of cognitive processing (McFarland, Frey, & Rhodes, 1980; Mistler-Lachman, 1974), which, if compared to reading, requires deeper and more extensive processing and subsequently results in higher memory scores. A typical experiment that demonstrates the generation effect utilizes word-pairs and compares a "read" to a "generate" condition. For example, at study the subject is given a cue and a target to read (e.g., table-chair) or a cue and target to be generated (e.g., table-ch___). At test, the subject is provided with the cue (table) and must then recall the target (chair). Both recall and recognition measures have consistently shown an advantage for the generated items. The generation effect has been confirmed by many investigators (Blaxton, 1989; Jacoby, 1983; Jacoby & Dallas, 1981; Smith & Branscombe, 1988; Winnick, Kooper & Sprafkin, 1974) and one interpretation is that in generation experiments, the study task calls for a greater degree of cognitive activity compared to reading. This interpretation is of particular interest for this study.

There are a number of types of generation. Winnick and Daniel (1970) used generation of a word from its definition or from a picture of the word at encoding compared to reading the word. Both types of generation (from a definition or a picture) produced significantly higher free recall scores [explicit memory] than reading the word. In contrast, on a threshold measurement, there was a significant increase in scores found in the read condition compared to either of the generate conditions. Thus generation, where the target word is produced from a picture of an object or from its definition, is quite different from reading the word and has a much larger effect on explicit than implicit memory performance.

Although the generation task has been viewed as a deeper or more extensive processing task and thus similar to the conceptual processing of a levels of processing paradigm, there are differences between a standard levels of processing task such as that of Craik and Tulving (1975) and a generation task such as that of Slamecka and Graf (1978). Generation as used in the Slamecka and Graf (1978) and Winnick and Daniel (1970) studies is a qualitatively different form of processing compared to the standard levels of processing of Craik and Tulving. A standard levels of processing task presents either a perceptual (e.g., How many "e's" are in the word?) or a conceptual (e.g., Does the word refer to something that is alive or not?) instruction requiring a Yes or No response. Although attention is directed toward different aspects of the words (surface versus semantic features) in each case, reading is a more passive type of activity in which all of the information is being presented and the individual merely reads the item. In a typical generation experiment, the active processing operation - generation - is being compared to a passive type of processing - reading - of the presented information. With this type of comparison, there is a confounding of an active versus passive encoding activity. To eliminate this type of confound, it was decided that the present work would not use a read/generate condition in the same experiment but would use the read conditions in one experiment and the generate conditions in the other experiment while maintaining the levels of processing distinction across experiments.

Generation activity has been previously studied in various forms in different experiments. For example, generate the second word of a word-pair (Slamecka & Graf, 1978), generate a word from its definition or picture (Winnick et al., 1974), generate a word from a sentence with the word missing (Mitchell, Hunt, & Schmitt, 1986), or generate a sentence from randomly presented words (Graf, 1982). In each case, however, the target word has been generated. In contrast, in the present work, the target word was presented and the perceptual or conceptual processing task was generated.

Craik (1977, 1984) has proposed that older adults have reduced processing resources, limiting potential for spontaneously carrying out elaborative processing as effectively as younger adults. Thus, it was reasoned that memory performance of older adults might be improved by requiring them to engage in an active cognitive processing task such as generation. Studies of the generation effect have found that both younger and older adults benefit from generation (Johnson, Schmitt, & Pietrukowicz, 1989; McDaniel, Ryan, & Cunningham, 1989; Mitchell, et al., 1986;

Rabinowitz, 1989) when compared to a read condition. However, although generation has been found to improve performance of both groups, in most studies the younger adults are found to perform on a higher level on explicit memory tests performance than the older persons (Hashtroudi, Johnson, & Chrosniak, 1989; Light & Albertson, 1989; Mitchell et al., 1986; Rabinowitz, 1989)on recognition as well as cued recall tests. Therefore, the question still remains: Could age-related memory differences be reduced on explicit tests by introducing generation as a processing task?

Explicit and Implicit Memory Tasks

Verbal memory is typically studied by introducing a memory task following a study phase. Tests of memory may be of several types, but the two of interest here have been found to differ in a number of ways. Explicit memory tests instruct subjects, after the study phase, to try to remember previously presented items. Such instructions activate the search process; hence, performance on these memory tests is greatly influenced by conceptual encoding. The three explicit tests most often used in explicit/ implicit comparisons are free recall, cued recall, and recognition. These tests differ in the demands made on the subject, but their common aspect is that the subject is specifically asked to remember previously studied words. For example, to test free recall, following study of a set of words (with or without instructions to learn) participants are asked to write or say as many words as they can remember in any order. In cued recall, the first three letters of a word are shown, and subjects are asked to complete the word with a word seen during the study phase. In a test of recognition, subjects are shown a list of words half of which were previously seen and half not seen; they are asked to respond "Yes" if they recognize the word as having been seen before, and "No" if they do not. In comparison with implicit tests to be described, instructions to remember items previously seen define the explicit tests.

In 1985, Graf and Schacter identified a type of memory test in which no reference was made to the study phase of the experiment and which therefore did not require conscious recollection of the experience; memory was viewed as a "facilitation in performance" (Graf & Schacter, 1985). The authors distinguished explicit memory from this type of memory and differentiated the two by introducing the term "implicit memory" for the second. Three commonly used implicit tests are lexical decision, word stem completion, and word fragment completion. In contrast to explicit memory tests, the instructions that are presented for an implicit memory test make no reference to the study portion of the experiment. For example, in a lexical decision test, following word study, subjects are very briefly shown combinations of letters on a screen one at a time, some previously presented words and some non-words, and are asked to decide if the word is a real word or non-word. On a Word Stem/Word Fragment Completion Test, subjects are shown either the first three letters of a word or the word with missing letters and are asked to complete the word with "the first word that comes to mind". In each of these tests, no reference is made to the earlier study episode. However, it has been consistently shown that subjects will make faster lexical decisions, or will complete word stem and word fragments with more words previously seen at study than with words not seen before. This phenomenon has been termed <u>direct</u> or <u>repetition priming</u>.

Interest and debate about this explicit/implicit dichotomy have been aroused by dissociative effects. An explicit/implicit memory dissociation occurs when an experimental manipulation produces different effects on explicit and implicit memory. There are single and double dissociations. A single dissociation occurs when an independent variable (e.g., conceptual processing) affects performance on one task but not another (e.g., looking at pictures results in higher explicit memory scores than reading words, but reading words and looking at pictures result in similar implicit memory test scores). A double dissociation occurs when two independent variables (e.g., perceptual and conceptual processing) affect performance on one task in one way and have the opposite effect on another task (e.g., looking at pictures results in higher explicit memory scores than reading words, but reading words results in higher implicit memory scores than looking at pictures). One example of a single dissociative effect is that of study-test changes in modality of presentation and other types of surface information (Graf, Shimamura, & Squire, 1985; Jacoby & Dallas, 1981; Roediger & Blaxton, 1987). Tests of implicit memory have been shown to be highly sensitive to such changes, whereas tests of explicit memory are not.

To explain the differential effect of particular variables on explicit and implicit memory, cognitive psychologists have developed a processing account (Roediger & Blaxton, 1987) based on the cognitive operations performed at study and test, particularly the match of operations occurring at study and test (Blaxton, 1989). Jacoby (1983) has developed a data-driven versus conceptually driven processing distinction to explain the dissociations between explicit and implicit memory tests. Data-driven processing concentrates on sensitivity to perceptual features, whereas conceptually driven processing focuses more on semantic effects. The processing accounts concentrate on differences in performance derived from differences in types of processing at study and similarity in processing at input and retrieval.

Among neuropsychologists, on the other hand, the concentration is on the specific different brain structures functionally necessary for the expression of explicit memory (the hippocampus and related structures) and of implicit memory (whose neural basis is just beginning to emerge [Schacter, Chiu, & Ochsner, 1993]). Squire (1992) has developed a "memory taxonomy" of two categories, declarative (explicit) and nondeclarative (implicit) memory.

Although a number of variables have differential effects on explicit and implicit memory performance, the many dissociations found to date in explicit/implicit memory experiments have not been explained adequately by either viewpoint. Cognitive psychologists' processing views are largely supported by results obtained with normal subjects, whereas the multiple memory systems view is supported by findings with patients who have memory deficits. Studies with older adults have found similarities in their memory performances to those of various patient groups (Butters, Heindel, & Salmon, 1990; Hashtroudi, Chrosniak, & Schwartz, 1992; Winocur & Moscovitch, 1990; Wright & Payne, 1985). Therefore, older adults were chosen for the present investigation.

There is no consensus in the literature as to the definition of "elderly" (Boone, Miller, Lesser, Hill, & D'Elia, 1990; Chiarello & Hoyer, 1988; Graf, Uttl, & Tuokko, 1995; Java, 1992; Java, 1996; Java & Gardiner, 1991; Light &

Singh, 1987; Schacter, Cooper, & Valdiserri, 1992). In the present research, "older" is defined as 70 or more years of age. This definition was based on the finding of significant cognitive decline in memory functioning between subjects in their sixties and subjects in their seventies (Schaie, 1990).

Neuropsychological Tests of Frontal Lobe Function and Their Relationship to Memory Function

Various memory functions have been attributed to the frontal lobes, among them planning, organization and executive aspects of memory; a cognitive mediation system in encoding and retrieval of memories, and the semantic retrieval of words (Luria, 1973, 1976; Shallice, 1982; Warrington & Weiskrantz, 1982). The findings of frontal lobe involvement in memory functions, in combination with the findings of neuroanatomical changes in frontal lobes with age (Alavi, 1989; Coffey, et al., 1992; Haug, 1985; Hooper & Vogel, 1976; Mittenberg, Seidenberg, O'Leary & DiGiulio, 1989; Terry, DeTeresa & Hansen, 1987; Tomlinson, Blessed, & Roth, 1968; Warren, Butler, Katholi & Halsey, 1985) give valid reason to utilize frontal lobe functioning tests in studies of healthy older adults and has been done in a number of studies (Boone, Miller, Lesser, Hill and D'Elia, 1990; Craik, Morris, Morris and Loewen, 1990; Libon, Glosser, Malamut, Kaplan, Goldberg, Swenson and Sands, 1994; Whelihan & Lesher, 1985). Frontal lobe functioning tests are neuropsychological tests that are behavioral measures that are carried out to find out about the neurological underpinnings of these behaviors. They are indices of the cognitive functioning of an individual and the results of these tests can be utilized to infer the area of the brain that is involved. The two frontal lobe tests that were used in the present study consisted of either a phonemic (F-A-S) or semantic (Animal Naming) processing component which were important factors in the present research and have previously been shown to have a differential effect on neural activity in the frontal lobes (Kapur, Craik, Tulving, Wilson, Houle, & Brown, 1994; Paller & Kutas, 1992). Correlational analyses were performed which gave promise of providing information about the extent of frontal lobe involvement for each level of processing (perceptual and conceptual) and for the standard (Y/N response) and elaborative, cognitively active (generative) types of encoding tasks in younger and older persons.

Rationale of the Present Experiments

The two experiments of this study examined the effect of two levels of processing (perceptual and conceptual) and two processing paradigms (standard versus generation) and evaluated their effects on memory performance in younger and older adults (see Figure 1). Experiment 1 provided a necessary baseline to determine if the levels of processing effect would be replicated and if the younger and older

Example of target word: Airplane

Type of Processing	Level of Processing: Perceptual	Level of Processing: Conceptual
Standard	"Are there any e's in the word? (Yes/No)	"Alive?" (Yes/No)
Generation	Say 5 words with same first letter as word shown (airplane)	Make up a sentence using the word shown (airplane)

Figure 1. Logic of the experimental design for the present experiments. The aim is to manipulate memory test performance by the level and type of processing performed at encoding.

adults would differ as in previous studies. In Experiment 1, subjects performed the standard levels of processing task at study (i.e., answering Yes/No to a perceptual and conceptual question); and in Experiment 2 effects of perceptual and conceptual generation tasks on memory were studied.

Rather than have the subject generate the target word, as in previous generation experiments, the present work incorporated a novel feature which presented the subject with the target word at study and required the subject to generate five words that began with the same letter as the target word (perceptual processing) or to generate a sentence that included the target word (conceptual processing).

Slamecka & Katsaiti (1987) have suggested that the generation effect is an artifact of "selective displaced rehearsal," which results because of a suppression of the read items rather than an enhancement of generate items. When the two types of study items are presented in the same list, the generate trials occupy the subjects' attention at the expense of the read trials. The present work separated the read and generate conditions between Experiments 1 and 2 while maintaining the perceptual and conceptual processing conditions in each of the experiments. By requiring that the subjects perform two types of generation tasks, rather than a read versus generate task, the selective displaced rehearsal theory was challenged because both tasks were generated (a sentence including, and five words beginning with, the same first letter as the target word), and there was no suppression of a read item to account for possible differences in the results. Any differences found between the perceptual and conceptual generation conditions might then be attributed to the processing task.

To determine whether conceptual processing affects implicit memory performance, the present work studied the effect of conceptual processing on implicit memory tests by utilizing the implicit memory test that has been most extensively studied in this regard (Weldon, 1991; 1993), and attempted to extend the findings to older adults.

Based on the production deficiency hypothesis of Craik (1984), it was hypothesized that conceptual processing would benefit the explicit memory test performance of both younger and older adults in a standard levels of processing task, but younger adults would obtain significantly higher memory scores than older adults. The generation task in the second experiment would have then been found to reduce the difference between the groups on the explicit memory test that is not related to selective displaced rehearsal (Slamecka & Katsaiti, 1987), but rather to the requirement of effortful cognitive processing on the part of the older adults that is not normally engaged in spontaneously (Craik, 1984). Conceptual processing was predicted to benefit implicit memory test performance of the younger adults more than that of the older in Experiment 1. In Experiment 2, generation (effortful cognitive processing) was predicted to enhance the implicit memory performance of both groups. However, it was predicted that the advantage of the younger adults over the older adults would remain in the conceptual processing condition.

Experiment 1

Experiment 1 presented standard processing tasks of minimal complexity (i.e., answering Yes/No questions) requiring perceptual or conceptual judgments about single words. There were three objectives: to replicate previous levels of processing experiments' findings on an explicit memory test in younger and older adults; to determine the benefit of conceptual encoding conditions for younger adults compared to older on explicit tests; and to determine if there is an effect of conceptual processing on an implicit memory test for older adults similar to that expected for younger adults. In addition, it provided baseline comparisons for a novel processing task in Experiment 2.

Method

Participants. Twenty-four 18 to 35-year-old Queens College undergraduates participated as a course option. Twenty-five 70 to 89 year olds were solicited from Senior Citizen Centers in the Queens, New York, area and from distribution of flyers in several areas of Queens. All subjects completed a background questionnaire (Appendix A).

Subjects were selected based on the following inclusionary criteria: English as a primary language; age range 18 to 35 for the younger adults and 70 to 89 for the older adults; a score of 25.0 or higher on the Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975) for the older group to screen for dementia. One participant was eliminated from the analysis due to an inability to complete the testing because of time constraints. Exclusionary criteria for both groups were history of head trauma, epilepsy, and neurological disease.

Apparatus and Materials. The material to be studied consisted of 128 target words (Appendix B) of 6 to 9 letters, of low, medium, or high frequencies, most of which were taken from Paivio, Yuille, and Madigan's (1968) rating of 925 nouns.

The entire experiment (instructions for the study and test portions of the experiment, the study task, and the explicit and implicit tests) was presented on a Compaq Contura Personal Computer. All responses and latencies were recorded by computer.

Experimental Design. Two lists of words were used at study (see Lists 1 and 2 in Appendix B), forming one "between-Ss" variable. The order of presentation of the two blocked study conditions (conceptual task first or perceptual task first), which were counterbalanced across subjects, formed a second "between-Ss" variable, and age (younger adults vs. older adults) was a third "between-Ss" variable. It was not anticipated that List or Order would be significant. They were included as factors in the design to verify that the word lists were comparable and that there were, in fact, no order effects. Two "within-Ss" variables were the two processing task conditions (perceptual/ conceptual), and the two tasks at test (recognition and word fragment completion), administered to each subject during the experimental session. This resulted in a 2 (List) x 2 (Order of Presentation) x 2 (Age Group) x 2 (Processing Task) mixed design. Each of the memory tests was analyzed separately. The dependent response measures were proportions of correct responses on each task and latencies to respond at test. For recognition, baseline data were provided by the number of new words identified as having been seen before. For word fragment completion, baseline data were the number of new word fragments for which target words were given.

Procedure. Informed consent (Appendices C and D) was obtained from all subjects (Table 1). Subjects were tested individually, test duration was approximately one hour. Each experimental session was as follows: Instructions preceded the appearance of the words on the computer screen for each processing condition. The subject read the

Table 1

Demographic Characteristics of Younger and Older Adults in Experiments 1 and 2

Variable	Younger Adults M	Younger Adults SD	Older Adults M	Older Adults SD
	Experiment 1			
Age (years)	20.33	4.59	76.71	4.75
Education (years)	13.06	.89	11.29	2.47
Vocabulary Scores	38.83	10.65	39.92	11.07
	Experiment 2			
Age (years)	20.33	2.46	76.46	4.68
Education (years)	13.40	.87	12.54	2.60
Vocabulary	43.67	9.29	45.83	13.15
	Experiment 1			
	n	%	n	%
Sex				
Male	6	25	5	20.8
Female	18	75	19	79.2
	Experiment 2			
Sex				
Male	4	16.7	4	16.7
Female	20	83.3	20	83.3

instructions, after which the experimenter asked if there were any questions. If there were no questions, the subject pressed the space bar and the experiment began. Subject was presented with one of the two study lists plus 12 buffers, 6 at the beginning of the word list and 6 at the end. The same 12 buffers were presented to all subjects and were not used in the memory test nor in the statistical analysis. These buffers were used to counteract primacy and recency effects. The 64 target words were presented in blocks, which in prior work has resulted in significant differences between groups (Challis & Brodbeck, 1992; Java, 1992; Java & Gardiner, 1991). Thirty-two of the words were preceded by the question, "Do each of the following words refer to something that is alive?" (conceptual), and 32 were preceded by the question, "For each of the following words are there one or more "e"s in them? (perceptual). Half of the words in each of the two lists named a living thing or a non-living thing, and half of the words contained one or more "e's" in them. The 64 words in each of the two study lists were counterbalanced so that each word appeared equally often in each of the two study conditions (perceptual/ conceptual). The two sets of questions were counterbalanced across blocks of words in each of the lists. Block presentation was counterbalanced across subjects.

Subjects responded to the questions by saying "Yes" or "No" and the experimenter pressed the appropriate "Y" or "N" key for each word presented on the screen. In the study portion of the experiment, if the subject's verbal response of "Yes" or "No" was not given within the allotted time, the next word appeared on the screen.

When the subject completed the study portion of the experiment, the test portion began. The two tests were constructed as follows: 32 of the target words from Study List 1 and 32 of the target words from Study List 2 formed the two Recognition and Word Fragment Completion Tests (64 words each), so that each test consisted of 32 words seen before and 32 words not seen before (the baseline condition). The two forms of each test were counterbalanced across subjects.

The order of testing proceeded as follows: First, the Word Fragment Completion instructions appeared on the screen. After the subject read the instructions, the experimenter asked if there were any questions. If there were no questions, the subject pressed the space bar and the Word Fragment Completion Test began. The subject responded verbally and the experimenter typed in the missing letters of the word displayed on the screen. All subjects took the Word Fragment Completion Test before the Recognition Test to minimize the possibility that subjects would become aware that a memory test was involved.

When the subject completed the Word Fragment Completion Test, the Recognition Test instructions appeared on the screen. After the subject read the instructions, the experimenter asked if there were any questions. If there were no questions, the subject pressed the space bar and the Recognition Test began. The subject responded verbally, either "Yes" or "No", and the experimenter pressed the appropriate keys. In the test portions of the experiment, if the subject did not complete the word for Word Fragment Completion or did not give the verbal response of "Yes" or "No" for Recognition within the allotted time, the next word would appear on the screen.

Presentation of all words in the study and test conditions was timed: 5 seconds for study conditions, 20 seconds for word fragment completion, and 10 seconds for recognition. For each of the blocks in the study tasks and for the two tests (Recognition and Word Fragment Completion), the 64 words were presented in a different randomized order for each subject.

Neuropsychological Tests. After the completion of the experiment, the Vocabulary subtest of the Wechsler Adult Intelligence Scale - Revised (WAIS-R) was administered to all subjects.

Next, two measures of presumed frontal lobe functions were administered: 1) Phonemic Controlled Oral Word Association Test (F-A-S), and 2) Semantic Controlled Oral Word Association Test (Animal Naming - COWA). In the F-A-S test, a letter is given, for example, "F", and the subject is told to say as many words as he/she can think of that begin with that letter as quickly as he/she can until told to stop, with one minute for each letter (F-A-S). The score is the total number of words generated per letter, excluding repeats, the same word with a different ending (e.g., eat/eating), and proper names of people or places.

The Animal Naming Test is a conceptual word fluency test. In this test, the experimenter asks the subject to name as many animals as he/she can think of, as quickly as possible. Instructions are that any animals can be used: "They can be from the farm, the ocean, the jungle, or they can be house pets". The experimenter times the subject for a total of 90 seconds, and the score is based on the 60 seconds with the highest word production. Instructions for each of the tests were read to the subject by the experimenter. Responses were timed with a stopwatch (one minute for each of the three sections of the F-A-S Test and 90 seconds for the COWA Test (total four and a half minutes). Subjects' responses were manually recorded. The dependent measures for the correlational analyses of the frontal lobe functioning tests were the number of responses produced in the allotted time for each of the verbal fluency tests (phonemic and semantic).

Results

Figure 2 shows the proportion of correct words at baseline and in each of the levels of processing conditions for each of the tasks for each group. For the recognition task, proportion of correct words chosen was higher in the conceptual processing than in the perceptual processing condition for younger and older adults. The baseline condition (false alarm rates) had the lowest proportions correct. On the Word Fragment Completion Test, proportions correct were almost equivalent in the conceptual and perceptual processing conditions for both groups. The perceptual and conceptual conditions were well above the baseline condition (words not seen before). For all conditions on the two tests, the younger adults' proportions correct were higher than those of the older adults.

Scores for Experiment 1 were analyzed by means of a Four-Way Mixed Model Analysis of Variance, performed separately for each memory test.

Recognition - Proportions Correct. Analysis showed no significant main effects for either word list or order and no significant interactions. There were significant main effects for group, F (1,40) = 6.74, MSE = .204, p = .01, with younger adults obtaining significantly higher proportions correct than older adults; and for levels of

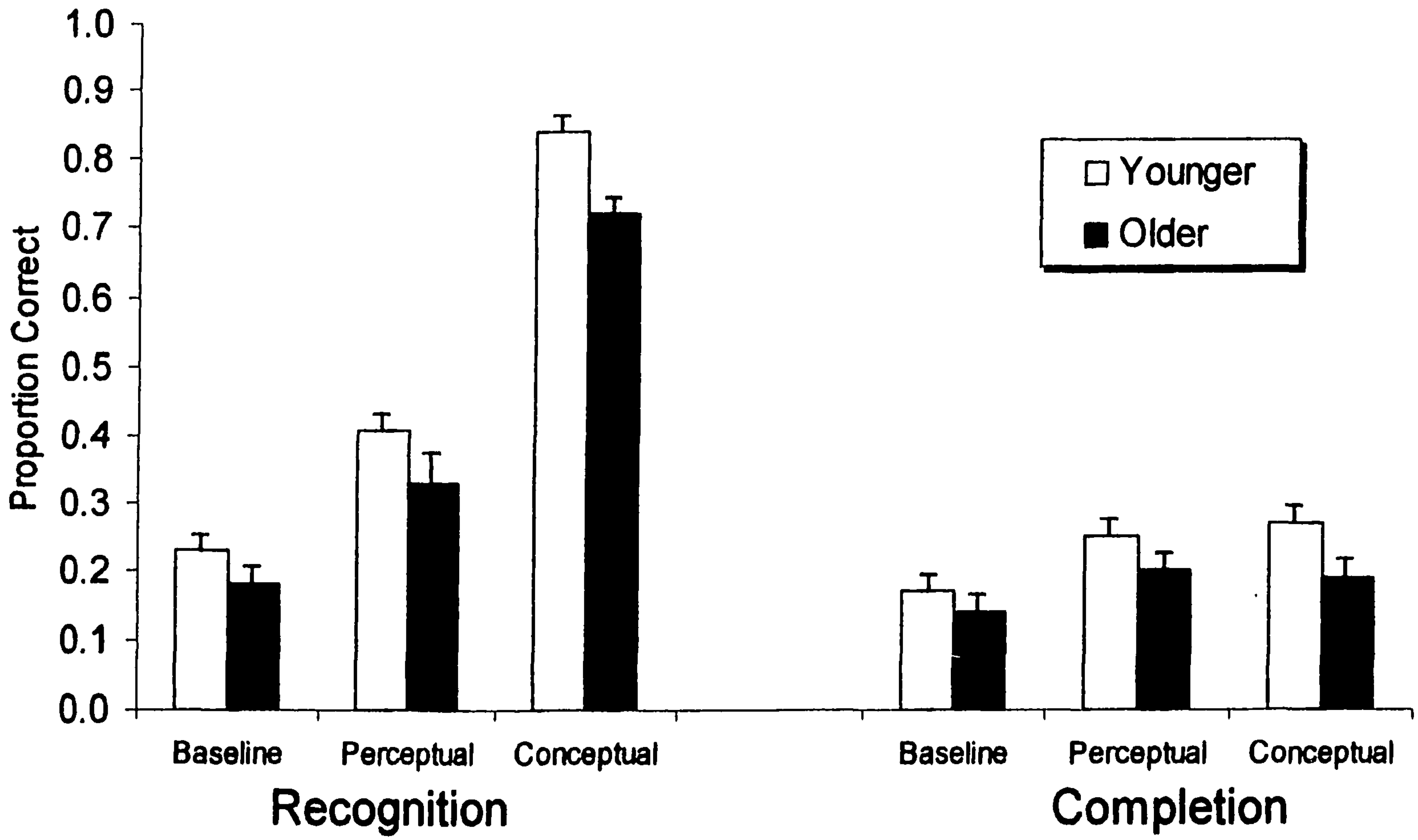

Figure 2. Proportions correct, in Experiment 1, for younger and older groups on Recognition and Completion Tasks for baseline values and for words processed perceptually and conceptually.

processing, F (1,40) = 324.58, MSE = 3.99, $p < .001$, with conceptual processing resulting in significantly higher proportions correct than perceptual processing. There were no significant interactions.

Planned comparisons using the t statistic (two-tailed) revealed that recognition scores differed significantly for conceptual processing (younger adults [.83 $\pm$ .12] versus older adults [.72 $\pm$ .14], $t(46) = 2.98$, $p = .005$), but not for perceptual processing (younger adults [.40 $\pm$ .14] versus older adults [.34 $\pm$ .18], $t(46) = 1.54$, $p = .129$).

Word Fragment Completion - Proportions Correct. Analysis showed no significant main effects for either word list or order and no significant interactions. There was a significant main effect for group, $F(1,40) = 5.50$, MSE = .098, $p = .02$, with younger adults obtaining significantly higher scores than older adults. There was no main effect of processing nor were there any interactions of group x processing. The two age groups differed in the conceptual processing condition, the younger having significantly higher scores than the older adults, but not in the perceptual processing condition. This conclusion is borne out by a t test for the former condition: younger adults (.27 $\pm$ .14) versus older adults (.19 $\pm$ .12) $t(46) = 2.13$, $p = .04$.

Figure 3 shows the latencies to respond (for correct responses only) for each of the tasks for each group. It

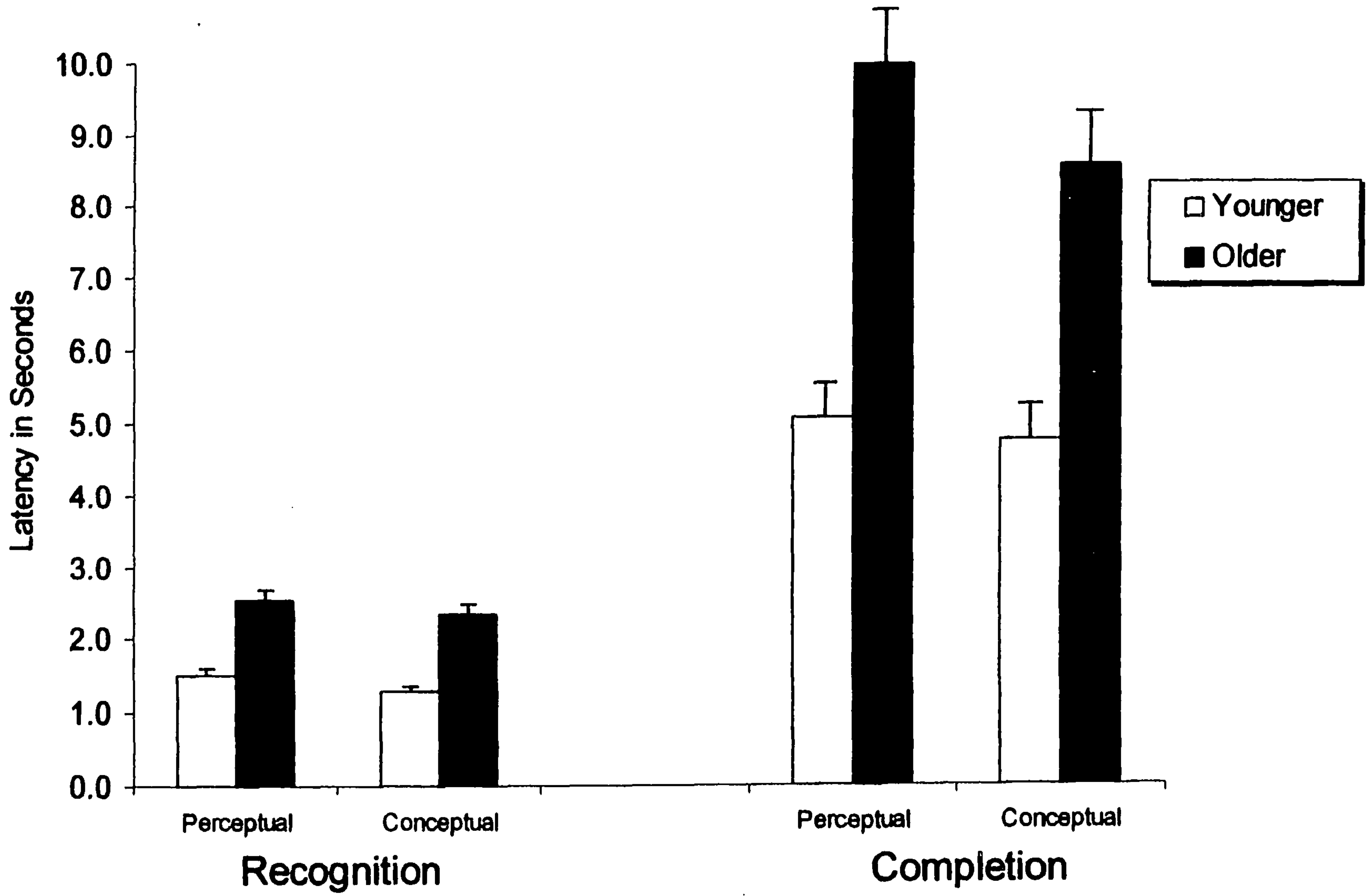

Figure 3. Latency for Correct Responses at Test in Experiment 1, for younger and older groups on Recognition and Completion Tasks for words processed perceptually and conceptually.

shows that, for both the recognition and word fragment completion tasks, latency to respond was longer for older than for younger adults in both the perceptual and conceptual processing conditions.

The latency data for Experiment 1 were analyzed by a Four-Way Mixed Model Analysis of Variance for each memory test. Both the between- and within-subjects factors were the same as for the proportions correct data. The dependent variable was the latency in seconds to correctly respond on each task.

Recognition - Latency. Analysis showed no significant main effects for either word list or order and no significant interactions for these variables. There were significant main effects for group, F (1,40) = 31.19, MSE = 25.94, p = <001, with younger adults having significantly shorter latencies to respond correctly than older adults; and for levels of processing, F (1,40) = 8.14, MSE = 1.06, p = .007. Conceptually processed words had significantly shorter latencies than perceptually processed words. There were no significant interactions.

Planned comparisons using the t statistic (two-tailed) revealed that latency to respond differed significantly for both conceptual processing (younger adults [1.28 $\pm$ .24] versus older adults [2.33 $\pm$ .79], $t(46) = -6.16$, $p < .001$) and perceptual processing (younger adults [1.50 $\pm$ .43] versus older adults [2.53 $\pm$ .99], $t(46) = -4.73$, $p < .001$).

Word Fragment Completion - Latency. Three subjects (1 younger/2 older) with missing values (no correct responses in one of the two processing conditions) were excluded from the analysis. The analysis showed no significant main effects for either word list or order and no significant interactions. There was a significant main effect for group, $F(1,37) = 55.68$, MSE = 488.55, $p < .001$, with younger adults having shorter latencies to respond than older adults. There was no main effect for processing, nor were there any interactions. The two age group means revealed that the groups differed for both processing conditions, and this conclusion is borne out by a t test for both the conceptual (younger adults [4.95 $\pm$ 2.15] versus older adults [8.90 $\pm$ 3.35], $t(44) = -4.76$, $p < .001$), and perceptual (younger adults [5.07 $\pm$ 2.50] versus older adults [10.38 $\pm$ 3.81], $t(45) = -5.68$, $p < .001$) processing conditions.

Neuropsychological Tests. An independent t test (two-tailed) showed that for both the F-A-S and Animal Naming test scores, the groups were significantly different (F-A-S - younger adults [38.96 $\pm$ 9.43] versus older adults [31.96 $\pm$ 6.08], $t(46) = 3.06$, $p = .004$; Animal Naming - younger adults [19.75 $\pm$ 4.28] versus older adults [14.33 $\pm$ 3.24], $t(46) = 4.95$, $p < .001$). Pearson product-moment correlations were computed to assess the relationship between the frontal lobe (F-A-S and Animal Naming) and Recognition and Word Fragment Completion (both perceptual and conceptual processing conditions) test scores. None of the correlations calculated for test scores with experimental findings were found to be significant.

Discussion

As expected, the younger group showed higher scores than did the older in both of the processing conditions. Furthermore, there was the suggestion that the younger adults benefited more than the older adults from conceptual encoding.

These findings agree with those of Craik and Tulving (1975), who found improved memory performance for conceptual compared to perceptual processing. The results also make the same suggestion as the findings of Light and Singh (1987), who reported that although younger and older adults benefited more from conceptual than perceptual encoding, age differences favoring the young were greater after conceptual compared to perceptual encoding.

The explicit memory findings are in general agreement with those in the literature, that is, conceptual encoding produces better explicit memory performance than perceptual (Howard, 1988; Light, 1988), and younger adults outperform older adults on explicit memory tests (Howard, 1988; Light, 1988). Additionally, the present findings agree with those in the literature regarding conceptual processing effects on implicit memory tasks (Chiarello & Hoyer, 1988; Davis et al., 1990). In this study, we found no effects of type of processing for either older or younger adults on the implicit test. However, there was a slight nonsignificant advantage with conceptual processing on the implicit test for younger adults compared to older adults.

There are two possibilities that might account for the implicit memory test results. The first is based on the putative influence of explicit retrieval on implicit test performance. When comparing a group of amnesic patients to a control group, Hamann and Squire (1996) suggested that "the effect of explicit retrieval is substantial in control subjects and much reduced but still detectable in amnesic patients, in proportion to their residual capacity for explicit memory" (p. 945). In the present study, the same reasoning can be applied to the older group. That is, to the extent that the older adults have lower explicit memory test scores than the younger adults, their explicit retrieval would be less likely to be involved on the implicit test. Additionally, younger adults may be more "test savvy" than older adults, and may be more readily able to utilize this retrieval approach even though they are instructed to answer "with the first word that comes to mind". However, most studies have found no significant difference between age groups on implicit memory tests. It would follow that, at least in those cases, both younger and older adults have utilized explicit retrieval. Even if that is the case, and both groups have utilized explicit retrieval to the extent they are capable, the groups may show a real difference on implicit memory tests.

The second explanation for the group difference in implicit memory scores is that it may be a consequence of limiting the response time (MacKay & Burke, 1990), thus eliminating the differential benefit of extra time normally offered to older adults in studies, based on the theory that memory deficits in old age arise from cognitive slowing (MacKay & Burke, 1990).

In summary, memory scores found in Experiment 1 suggest that 1) younger adults' explicit memory test performance surpasses that of elderly adults'; 2) younger adults have higher memory scores than older adults with conceptual processing on an explicit memory test; and 3) conceptual processing produces an advantage (although nonsignificant) for younger adults compared to older adults on the implicit test.

Younger adults had shorter latencies to respond than did older adults. These findings again raise the possibility that the differences in the groups are a result of a general cognitive slowing. It is not clear, however, if these results lend support to the conclusion that younger adults benefit more from conceptual processing than do older adults on either explicit or implicit memory tests. The neuropsychological test findings did not support any relationship between frontal lobe functioning and memory test performance.

The theoretical viewpoint that appears to gain support from Experiment 1 is the processing account (Roediger & Blaxton, 1987; Roediger, Weldon, & Challis, 1989). In the present experiment, there was a match in mental operations performed at study and test. The target words processed in the conceptual condition resulted in better performance on the Recognition Test, whereas words processed in the perceptual condition did not. The results of the Word Fragment Completion Test are also consistent with the processing account. As stated in the "Introduction," the Word Fragment Completion Test has been shown to incorporate both perceptual and conceptual processing components (Weldon, 1993). Both the perceptual and conceptual processing conditions resulted in similar scores for the groups, with the younger adults obtaining somewhat higher scores than the older adults in the conceptual processing condition only. The discrepancies found between younger and older adults in the conceptual processing condition on both the Recognition and Word Fragment Completion Tests needed further clarification on two points: 1) Are the differences between the groups a function of differences in storage capacity (i.e., actual brain deterioration?) or are they related to the manner in which the material is put into storage (i.e., the process involved)? 2) Are the differences the result of a general cognitive slowing?

As to these questions, it was concluded that the paradigm of the first experiment, requiring only Yes/No responses, may not have provided the encoding activation helpful to older persons, therefore the processing component in Experiment 2 was made more extensive at study. This is in line with the suggestion of Klein & Saltz (1976) that there are differential processing activities within the semantic realm and that meaning is not activated in an all or none fashion. The authors stated 22 years ago that "the issue of activation of levels of meaning is so new that the extent of applicability of this process has been relatively unexplored" (p. 679). Apparently, this concept has not been explored to date and therefore was incorporated into the present study within both the conceptual and perceptual processing tasks.

Hence, Experiment 2 introduced two encoding tasks requiring active generation at study, and, in the case of the conceptual encoding task, having more extensive meaning dimensions. It was predicted that this increase in encoding activation within both the conceptual and perceptual processing study tasks would reduce the magnitude of the group differences found in Experiment 1.

Experiment 2

The objectives of Experiment 2 follow. The first objective was to determine if actively generated conceptual processing conditions would produce higher scores than actively generated perceptual processing conditions on the explicit memory test for younger and older adults. Within the perceptual and conceptual levels of processing, are there levels of activation that affect explicit memory performance? The second objective was to determine if the generated conceptual task would produce a greater effect than the perceptual on the explicit and implicit test scores of the younger adults compared to the older adults. The third objective was to determine if the suggestion of a perceptual/ conceptual contrast in the older compared to the younger adults in Experiment 1 would be decreased by sentence generation.

To separate out the processing component from the general cognitive slowing component, Experiment 2 introduced a generation encoding task requiring more cognitive effort than the perceptual and conceptual questions used in Experiment 1. In Experiment 2, the conceptual processing condition required the subject to generate a sentence for each of the words presented on the screen, while the perceptual processing condition required the subject to generate five words beginning with the same letter as the word presented on the screen. Five words was selected because it was similar to the number of words generated in a sentence, based on previous work done with sentence generation (Winnick, Grix, Gallub, & Mace, 1995).

Asking that subjects generate a sentence, given a word, rather than to generate a single word, involves more effortful conceptual processing, while holding the level of perceptual processing constant by presenting the target word at study in each of the processing conditions. In the conceptual sentence generation condition, the word presented on the screen must initially be examined to determine its semantic referent, and a relevant sentence framework has to be superimposed. The sentence framework must obey grammatical rules as well as coincide with the semantics of the word. Therefore, more extensive processing must occur compared to generation of a word. To provide a generation control condition, generation was again used, but of a perceptual variety, namely, generation of words beginning with the same letter as the target word presented on the screen. Thus, for these baseline words, rather than searching for semantic relationships as in the case of generating a sentence, requirement of same first-letter words occasioned a search based more on non-semantic phonological similarities. Sentence generation and the control condition described have been found to elicit a difference on recognition but not on word stem completion in younger adults (Winnick et al., 1995).

This task was a modification of generation procedures described by Slamecka and Graf (1978) and investigated in a number of subsequent studies (Blaxton, 1989; Jacoby, 1983; Jacoby & Dallas, 1981; Smith & Branscombe, 1988). Of particular interest in these studies was the robust finding that memory scores for generated words were consistently superior to those for words that were read. Several studies indicated that generation benefits older adults to the same degree as younger adults (Johnson, Schmitt, & Pietrukowicz, 1989; McDaniel, Ryan, & Cunningham, 1989; Mitchell et al., 1986; Rabinowitz, 1989). In these studies, the target words were generated or read and, in each case, generated words resulted in higher memory scores than read words. In the present study, rather than generating the target word, the conceptual or perceptual processing requirement for the target word (i.e, a sentence for the word or five same-first-letter words) was generated.

By maintaining the same exposure time for target words as in Experiment 1, the time factor was held constant between experiments and, therefore, the analysis of the cognitive slowing remained consistent. The increase in the cognitive activation for the perceptual and conceptual processing conditions allowed further analysis of this feature.

These aspects of Experiment 2 were also the <u>same</u> as in Experiment 1: requirements to participate and inclusionary/exclusionary criteria; use of Compaq Contura Personal Computer; use of words of the same length (6-9 letters) and in the same frequency (low, medium, and high); proportions correct and latency recordings by the computer program; mixed experimental design (2 [List] x 2 [Order of Presentation of Study Blocks] x 2 [Age Group] x 2 [Processing Task]; the baseline data (recognition: false alarms and word fragment completion: correctly completed fragments not seen before); presentation of one of the two study lists plus 12 buffers, 6 at beginning of word list and 6 at the end, to counteract primacy and recency effects; time of words on-screen before screen went blank; counterbalancing of the two study blocks and two forms of each test across subjects; administration of each memory test, and of the vocabulary and two frontal lobe function tests; randomized order of words in study task blocks and the two memory tests.

Method

Participants. Twenty-four 18 to 35 year old Queens College undergraduates participated as a course option and comprised the younger group. For the older group, 27 persons 70 to 89 years of age were recruited from Senior Citizen Centers in the Queens, New York, area, and from distribution of flyers in the Queens area (see Table 1). Of the 27 older adults recruited, three were not included: one due to an inability to complete the testing due to time constraints, and two due to a history of head trauma. All subjects were different than those in Experiment 1.

Apparatus and Materials. The stimuli consisted of 96 target words arranged in two lists (see Appendix E). The words had been used in a previous study in which sentences were generated (Grix, 1993). For response recording, a Tele-Recorder 460 and TDK 90- and 100-minute cassette tapes.

Experimental Design. Mixed 2 (List) x 2 (Order of Study Block Presentation) x 2 (Age Group) x 2 (Processing Task) design. The two memory tests were analyzed separately.

Procedure. Informed Consent (Appendices F & G) was obtained from all subjects. Subjects were tested individually. Time for the entire testing of each subject was one and a half hours. Each experimental session proceeded in the following manner: 1) The perceptual or conceptual instructions preceded the appearance of the words on the computer screen for each processing condition. Twenty-four of the words were preceded by the "conceptual" instruction: "For each of the following words, say a sentence aloud that includes the word," and 24 were preceded by the perceptual instruction: "For each of the following words, say five words that begin with the same letter as the word on the screen". 2) The subject read the experimental instructions, after which the experimenter asked if the instructions were clear. If clear, the subject was then instructed to press the space bar, and the experiment began. The study list plus buffers were presented.

When subjects had completed their response, the experimenter pressed the space bar so that the next word would appear on the screen. In addition to tape recording the subjects' responses, the experimenter manually recorded whether the subjects completed the sentence or produced five same first-letter words for the word on the screen.

When the subject had completed the study portion of the experiment, the memory tests began. Twenty-four of the target words from Study List 1 and 24 of the target words from Study List 2 (Appendix E) formed the two Recognition and Word Fragment Completion Tests (48 words each), so that each test consisted of 24 words seen before and 24 words not seen before (baseline condition). For the test portion of the experiment, subjects responded orally, and the experimenter pressed the specific keys on the keyboard corresponding to the response.

For the study condition, the word remained on the screen for 5 seconds and then the screen remained blank until the subject completed the task for that particular word. For the Word Fragment Completion Test, 20 seconds was given to complete the word; for the Recognition Test, 10 seconds was given to respond (see Weldon, 1991; 1993). If the subject was unable to produce a sentence or to generate five words beginning with the same first-letter, he/she had the option to have the space bar pressed to see the next word. For the Recognition and Word Fragment Completion Tests, if the subject did not respond by pressing the necessary computer key(s) within the allotted time, the next word would appear on the screen.

Results

Figure 4 shows mean scores (proportions of target words) for baseline and the two processing conditions, for each of the tasks, for each group. It shows that, for the recognition task, proportion of correct words was higher for conceptually produced words for both younger and older adults. On the Word Fragment Completion Test, no differences were found for either task in the conceptually and perceptually processed conditions in both groups.

Proportions correct data were analyzed by a Four-Way Mixed Model Analysis of Variance for each memory test. The three between-subjects factors were the same as Experiment 1 (age group, word list, and order of block presentation), with List and Order not expected to be significant.

The within-subjects factor was levels of processing at study (perceptual versus conceptual). The dependent variable was the proportion of correct responses on each task.

Recognition - Proportions Correct. The analysis showed no significant main effects for word list or order and no significant interactions. For group, the independent

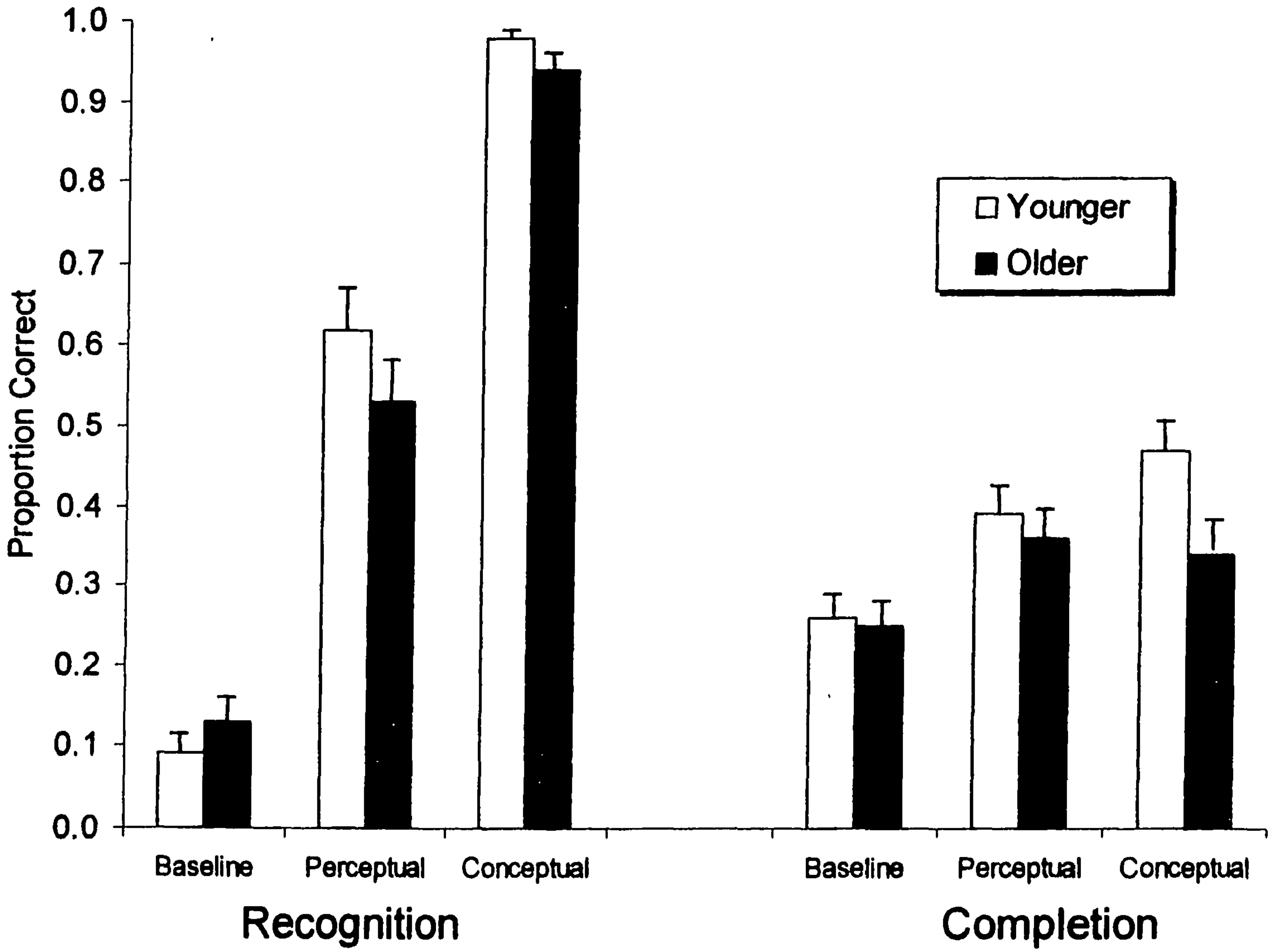

Figure 4. Proportions correct, in Experiment 2, for younger and older groups on Recognition and Completion Tasks for baseline values and for words processed perceptually and conceptually.

variable of particular interest, there was no significant main effect: F (1,40) = 2.22, p = .15. There was a significant main effect for levels of processing: F (1,40) = 112.45, p < .001, with conceptual processing resulting in significantly higher proportions correct than perceptual processing. There were no significant interactions.

Planned comparisons using the t statistic (two-tailed) revealed no significant differences between the groups in the conceptual processing condition (younger adults [.98 $\pm$ 3.54] versus older adults [.94 $\pm$ .11], $t(46)$ = 1.48, p = .15); or in the perceptual processing condition (younger adults [.62 $\pm$ .25] versus older adults [.53 $\pm$ .24], $t(46)$ = 1.21, p = .23).

The possibility of a ceiling effect in the conceptual processing condition (younger adults = .98 $\pm$ 3.54; older adults = .94 $\pm$ .11) warranted an additional analysis that excluded any subjects who had obtained perfect scores (100% Score N = 18 younger adults; 16 older adults). An ANOVA, analyzing these selected groups, and utilizing the same between- and within-subjects variables, had a similar outcome: There were no significant main effects for group (younger adults [.92 $\pm$ 0]; older adults [.83 $\pm$ .14], F(1.8) = 0.59, p = .47), word list, or order, and no significant interactions. The main effect of levels of processing continued to be significant: $F(1,8)$ = 18.30, p = .003. Thus, the group differences found in Experiment 1 were absent when more extensive processing conditions were introduced.

Word Fragment Completion - Proportions Correct. There were no significant main effects for either word list or order and no significant interactions. In addition, there were no significant main effects for either group or processing condition, and there were no significant interactions. The two age group means differed in the conceptual processing condition (younger adults [.47 ± .17] versus older adults [.34 ± .19], $t(46) = 2.49$, $p = .016$), but not in the perceptual condition (younger adults [.39 ± .19] versus older adults [.36 ± .19], $t(46) = .392$, $p = .697$).

Figure 5 shows the latency data for correct responses for each of the memory tests for each group. It shows that, as in Experiment 1, for both the Recognition and Word Fragment Completion tasks, latency to respond was longer for older adults in both the perceptual and conceptual processing conditions.

Additionally, for the Recognition Test, the latencies of conceptual processing responses were slightly shorter than in the perceptual processing condition for both groups. In contrast, on the Word Fragment Completion task, the conceptual processing condition response time was shorter for the older adults but slightly longer for the younger adults than in the perceptual processing condition.

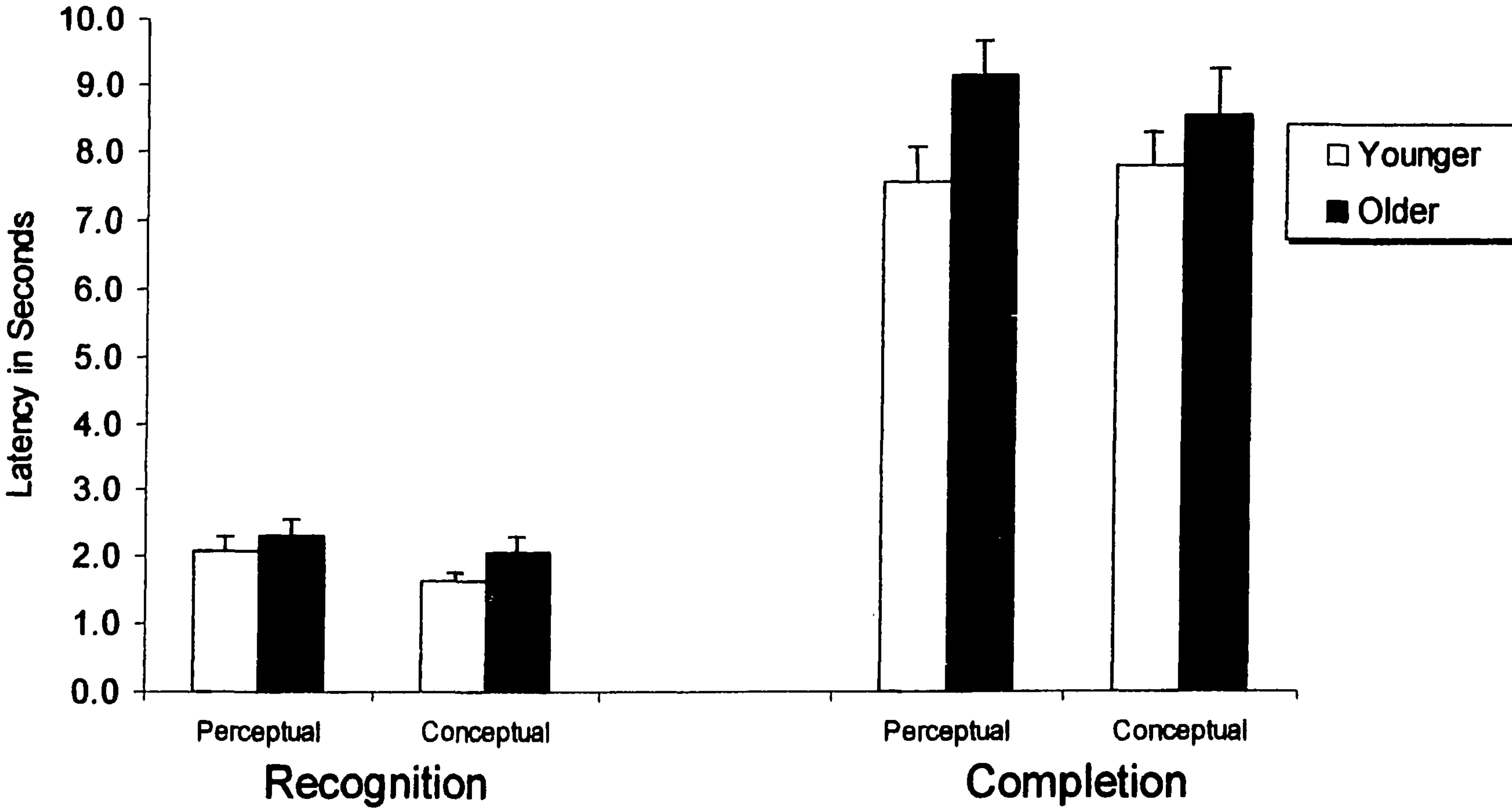

Figure 5. Latency for Correct Responses at Test in Experiment 2, for younger and older groups on Recognition and Completion Tasks for words processed perceptually and conceptually.

Additionally, although the latencies results of the older adults remained consistent from Experiment 1 to 2, the younger adults' response latencies on the Word Fragment Completion Test were longer in Experiment 2 for both the perceptual and conceptual processing conditions than was the case in Experiment 1.

The latency data for Experiment 2 were analyzed by means of a Four-Way Mixed Model Analysis of Variance for each memory test, with the same between- and within-subjects factors as in Experiment 1. The dependent variable was the latency to correctly respond, in seconds, on each task.

Recognition - Latency. There were significant main effects for group (F (1,40) = 5.65, p = .02, with younger adults having significantly shorter latencies to respond correctly than older adults), and effect of levels of processing (F (1,40) = 22.51, p < .001, with conceptually processed words having significantly shorter latencies to respond correctly overall than perceptually processed words). There were no significant interactions.

Planned comparisons using the t statistic (two-tailed) revealed that for the two groups, latency to respond differed significantly for conceptual processing (younger adults [1.63 $\pm$ .23] versus older adults [2.04 $\pm$ .58], t(46) = -3.174, p = .003), but not for perceptual processing (younger adults [2.08 $\pm$ .52] versus older adults [2.29 $\pm$ .59], t(46) = -1.32, p = .19).

Word Fragment Completion - Latency. Four subjects (2 younger/2 older) with missing values (no correct responses in one of the two processing conditions) were excluded from the analysis. Analysis showed no significant main effects for either word list, order, or group. However, there was a significant list x group interaction: $F(1,36) = 5.76$, $p = .02$. There was no significant main effect for processing nor were there any interactions. Planned comparisons using the t statistic (two-tailed) revealed no significant differences between the groups in each of the processing conditions (conceptual - younger adults [7.77 $\pm$ 2.29] versus older adults [8.90 $\pm$ 3.63], $t(45) = -1.29$, $p = .20$; perceptual - younger adults [8.23 $\pm$ 2.49] versus older adults [9.53 $\pm$ 3.09], $t(43) = -1.55$, $p = .13$).

Experiment 1 versus Experiment 2 - Proportions Correct.

In Experiment 2, proportions correct were higher than in Experiment 1 in all conditions for both groups (Table 2). The most disparate result was between the Recognition scores for the two groups, where there was a significant difference between the groups in Experiment 1 and no difference in Experiment 2, most notably in the conceptual (although nonsignificant) processing condition.

However, there were also differences in the vocabulary scores for the two groups between the two experiments (see Table 1). This raised the possibility that differences in

Table 2

Mean Proportions of Correct Responses in Experiment 1 and Experiment 2 for Recognition and Word Fragment Completion in Younger and Older Adults

	Younger Adults		Older Adults	
Test	Perceptual	Conceptual	Perceptual	Conceptual
		Experiment 1		
Recognition				
M	.41	.84*	.33	.72*
SD	.14	.12	.18	.14
Word Fragment				
M	.25	.27*	.20	.19*
SD	.13	.14	.11	.12
		Experiment 2		
Recognition				
M	.62	.98	.53	.94
SD	.25	.03	.24	.29
Word Fragment				
M	.39	.47	.36	.34
SD	.19	.17	.19	.19

*p=.05

vocabulary and, as such, differences in intelligence between the two groups could account for the differences in test scores. An independent samples t-test comparing younger (Experiment 1 mean vocabulary score = 38.38; Experiment 2 = 43.67) and older adults (Experiment 1 mean vocabulary score = 39.92; Experiment 2 = 45.83) across experiments showed no significant differences in vocabulary scores. The results were younger adults - Experiment 1 versus Experiment 2: $t(46) = -1.676$, $p = .10$; older adults - Experiment 1 versus Experiment 2: $t(46) = -1.686$, $p = .10$.

Although there were no significant differences in vocabulary scores across experiments, an ANCOVA was performed with the vocabulary scores as a covariate for proportions correct only (see Table 3). Table 3 shows minimal changes in scores. All scores remain very close to the original scores.

ANCOVA. Recognition - Experiment 1. The analysis of covariance remained the same as the ANOVA: no significant main effects for either word list or order and no significant interactions; a significant main effect for group $F(1,39) = 6.63$, $MSE = .206$, $p = .01$ with younger adults obtaining significantly higher proportions correct than older adults overall, and effect of levels of processing: $F(1,39) = 10.67$, $MSE = .132$, $p = .002$ with conceptual processing resulting in significantly higher proportions correct than perceptual processing. Utilizing a

Table 3

Mean Proportions of Correct Responses (Adjusted Means) in Experiment 1 and Experiment 2 for Recognition and Word Fragment Completion in Younger and Older Adults with Vocabulary as a Covariate

	Younger Adults		Older Adults	
Test	Perceptual	Conceptual	Perceptual	Conceptual
		Experiment 1		
Recognition				
M	.40	.84*	.33	.72*
SD	.14	.12	.18	.14
Word Fragment				
M	.25	.27*	.20	.19*
SD	.13	.14	.11	.12
		Experiment 2		
Recognition				
M	.63	.98	.52	.94
SD	.25	.03	.24	.29
Word Fragment				
M	.39	.48*	.36	.34*
SD	.19	.17	.19	.19

*p=.05

planned comparison t-test statistic, recognition scores for older and younger adults remained significantly different for conceptual processing.

ANCOVA. Recognition - Experiment 2. The analysis of covariance remained the same as the ANOVA: no significant main effects for either word list or order and no significant interactions; no significant main effect for group; an effect of levels of processing: $F(1,39) = 19.41$, MSE = .58, $p = <.001$.

ANCOVA. Word Fragment Completion - Experiment 1. The analysis of covariance remained the same as the ANOVA: no significant main effects for word list or order and no significant interactions; a significant main effect for group: $F(1,39) = 6.28$, MSE = .106, $p = .02$, with younger adults obtaining significantly higher scores than older adults. There was no main effect of processing nor were there any interactions. The difference between the two groups in the conceptual processing condition remained.

ANCOVA. Word Fragment Completion - Experiment 2. The analysis of covariance showed no significant main effects for word list or order. In contrast to the ANOVA, there was a significant main effect for group $F(1,39) = 4.29$, MSE = .175, $p = .05$, and a significant triple interaction of list x order x group $F(1,39) = 5.00$, MSE = .204, $p = .03$. There was no significant main effect for processing. However, using a planned comparison, the original difference between the groups in the conceptual processing condition remained.

Neuropsychological Tests. An independent samples t test (two-tailed) showed that for the Animal Naming test scores, the groups were significantly different (younger adults [20.67 ± 4.87] versus older adults [15.54 ± 4.95], $t(46) = 3.62$, $p = .001$), whereas for the F-A-S test scores they were not (younger adults [45.71 ± 10.23] versus older adults [40.50 ± 11.45], $t(46) = 1.66$, $p = .10$) (see Table 4).

Pearson product-moment correlations were computed to assess the relationship between the frontal lobe (F-A-S and Animal Naming) and Recognition and Word Fragment Completion (both perceptual and conceptual processing conditions) Test scores (see Table 5). Significant positive correlations were found for the younger adults between the F-A-S test and the Word Fragment Completion Test scores (in the perceptual processing condition) ($r = .43$, $p = .04$). Significant positive correlations were also found for the older adults between the F-A-S and the Word Fragment Completion Test scores in both the perceptual ($r = .40$, $p = .05$) and conceptual ($r = .51$, $p = .01$) processing conditions, as well as for the older adults between the Animal Naming and the Word Fragment Completion Test scores, in the conceptual processing condition ($r = .50$, $p = .01$).

Table 4

Neuropsychological Test Scores

	Experiment 1			
	Younger (n=24)		Older (n=24)	
Variable	M	SD	M	SD
F-A-S*	38.96	9.43	31.96	6.08
Animal Naming**	19.75	4.28	14.33	3.24

	Experiment 2			
	Younger (n=24)		Older (n=24)	
Variable	M	SD	M	SD
F-A-S	45.71	10.23	40.50	11.45
Animal Naming***	20.67	4.87	15.54	4.95

*p<.004. **p<.000. ***p<.001

Table 5

Correlation of Scores of Younger and Older Adults on Perceptual and Conceptual Conditions between Recognition and Word Fragment Completion Tests and Scores on Neuropsychological Tests - Experiment 2

Type of Processing	F-A-S	Animal Naming
Recognition Test		
	Younger Adults	
Perceptual	.18	.24
Conceptual	-.05	-.08
	Older Adults	
Perceptual	.20	.25
Conceptual	.05	.03
Word Fragment Completion Test		
	Younger Adults	
Perceptual	**.43****	.32
Conceptual	-.12	-.35
	Older Adults	
Perceptual	**.40***	.21
Conceptual	**.50*****	**.50*****

*p = .05. **p < .05. ***p = .01

Discussion

The change in processing conditions introduced in this experiment had a significant effect, the greatest of which was the elimination of group differences on the explicit memory test scores.

Experiment 2 introduced active processing of two kinds for target words. The requirement to generate five words beginning with the same letter as the word on the screen was a more active type of perceptual processing than the one required in Experiment 1. As in Experiment 1, it required a phonological, superficial, type processing. In the conceptual processing condition, the requirement to generate a sentence that incorporated the word on the screen was also an active, more elaborative type of processing than the response required in Experiment 1.

Generating a sentence requires semantic analysis and is a deeper type of processing than generating five words that begin with the same letter. As expected, this increase in both forms of cognitive complexity benefited younger and older groups, but in varying degree. For explicit memory test performance, the increase in the processing requirement resulted in the older adults performing on a level equivalent to the younger adults. In addition, although conceptual processing resulted in better memory performance than perceptual processing for both younger and older adults, contrary to Experiment 1, conceptual processing did not suggest a benefit for younger more than older adults.

The conceptual processing condition produced higher scores than the perceptual processing condition for both age groups, whether the processing task was standard or more complex. Although conceptual processing maintained its advantage over perceptual processing on explicit memory tests, even with an increase in cognitive activation, this increase appears to have benefited the older adults to a greater degree than the younger adults, even when the data were reanalyzed to account for the possibility of a ceiling effect.

Implicit memory findings were slightly different from those for explicit. As on the explicit test, group differences were eliminated and, as in Experiment 1, there was no effect of processing. However, the appearance of an advantage of the younger adults over older adults in the conceptual versus the perceptual processing condition remained. Although a non-significant conceptual processing difference between the groups occurred on the implicit test, the increase in cognitive activation appears to have eliminated the group differences found in Experiment 1 on the implicit test.

The latency data in Experiment 2 further support the reasoning that increased cognitive activation at encoding significantly improves older adults' performance. On the

Recognition Test, younger adults' response latencies were again shorter than those of older adults. However, on the Word Fragment Completion Test, there were no differences between the groups on response latencies. As previously stated, this lack of a difference between groups appears to be a result of the younger adults' response latencies being longer than they had been in Experiment 1, whereas the older adults' response latencies remained consistent with those in Experiment 1. Results of Experiment 2 suggest that differences between the groups cannot be attributed to cognitive slowing on the part of the older adults. Rather, differences between the groups can be attributed to processing that involves cognitive activation. On the explicit test, although response latency was still greater for older than for younger adults, the proportions correct were similar in both groups. Additionally, the older adults' latencies in Experiment 2 were actually shorter than those in Experiment 1. Therefore, cognitive activation enhanced older adults' response latencies as well as their memory scores. On the implicit test, the older adults' latencies were consistent with Experiment 1.

It appears that older adults have a significant benefit when processing requirements involve active participation. Possibilities to consider are the nature of the basis for this effect and if increased activation at encoding increases the involvement of the frontal lobes, which in turn enhances memory performance in older adults. Frontal lobe functioning test results in the present work appear to support this possibility. Previous work has shown differences in frontal lobe activity with perceptual and conceptual encoding in younger adults (Kapur et al., 1994; Paller & Kutas, 1992;) and reduced activation in encoding in older adults (Grady et al., 1995). This, combined with studies that have shown reductions in frontal areas of the brain in the elderly (Coffey et al., 1992; Haug, Barmwater, Eggers, Fischer, Kuhl, & Sass, 1983), suggested that correlating results of perceptual (F-A-S) and conceptual (Animal Naming) frontal lobe functioning tests with the perceptual and conceptual conditions of the explicit and implicit memory tests might suggest frontal lobe involvement in memory test performance (for similar work, see Nyberg, Winocur, & Moscovitch, 1997; Winocur, Moscovitch, & Stuss, 1996).

According to Lezak (1983), "word fluency as measured by F-A-S and similar techniques calling for generation of word lists has proven to be a sensitive indicator of brain dysfunction. Frontal lesions, regardless of side, tend to depress fluency scores" (p. 332). As previously stated, in the process of normal aging, there is frontal lobe deterioration (Coffey et al., 1992; Haug et al., 1983) and significantly lower cerebral blood flow in frontal areas than is the case for younger adults (Grady et al., 1995).

Two recent studies' (Winocur et al., 1996; Nyberg et al., 1997) results have found positive correlations between the F-A-S test and explicit and implicit memory tests in older adults, and the results suggest that frontal lobes are involved in certain memory performance. Based on the foregoing information, studying correlations between the two frontal lobe test results with the explicit and implicit memory tests to determine the extent of frontal lobe involvement in memory performance seemed applicable. In the present study, the correlational analyses were used to tease out the perceptual and conceptual components of the frontal lobe tests and the explicit and implicit memory tests. They were also used to differentiate the frontal lobes' involvement in standard versus more actively generated processing tasks.

In contrast to Experiment 1, which found differences between the groups on both frontal lobe functioning tests, Experiment 2 found a significant difference between the groups on the Animal Naming test but not on the F-A-S test. It appears that an increase in cognitive activation benefited the older adults on the perceptual processing frontal lobe test. The increase in activation increased the phonemic naming ability of the older adults to the extent that there were no longer any differences between their test scores and those of the younger adults on this test and positive correlations were found.

All of these positive correlations strongly suggest a connection between frontal lobe functioning and memory. These correlations also suggest, particularly for older adults, that active encoding processes result in the mobilization and use of conceptual information that is stored in the brain, but that might otherwise lie dormant and inaccessible to aid in retrieval of information. In Experiment 1, no significant correlations were found, suggesting that when the cognitive activity required at study is passive rather than active (as in Experiment 1), frontal lobe involvement is lessened and, therefore, the effect of frontal lobe activation on memory performance is likewise lessened. In Experiment 2, the requirement to actively generate the perceptual and conceptual processing component of the study task increased frontal lobe activity, which had a positive effect on memory performance. This is supported by the increase in memory scores for the two age groups, the lack of a difference between the age groups on the phonemic frontal lobe test, as well as the positive correlations found between the frontal lobe functioning tests and the implicit memory test. When cognitive activation increases at study, as it did in Experiment 2, the Moscovitch model (1989) is supported. That is, Experiment 2 provided evidence that when activation at study is increased, the frontal lobes contribute to implicit but not explicit memory test performance, particularly in older adults. These findings will be discussed further in the "General Discussion."

To summarize, Experiment 2 showed that when cognitive stimulation, in the form of active versus passive encoding activities, increased at input, there was no longer an overall difference between age groups on either the explicit or implicit tests. There was still more benefit from conceptual than from perceptual processing on the explicit test overall. However, the older adults were no longer at a disadvantage in the conceptual processing condition compared to the younger adults. In contrast to the explicit test, the younger adults still maintained a slight non-signficant advantage in the conceptual processing condition compared to the older adults in the implicit test.

With the increase in cognitive activation required by the generation task, the response latency of older adults remained consistent with their response latency in a less cognitively active task, but the younger adults' latency to respond increased. Results of the frontal lobe function tests also showed the benefit of increased activation at encoding. Overall, it appears that older adults have a significant benefit in memory performance when processing requirements involve active participation. The significant benefit in memory performance does not appear to be related to vocabulary scores (Table 3), but may be related to increased activation of the frontal lobes.

General Discussion

The prominent finding of this study is the contrast in performance evoked by a standard passive processing task versus an active, generational, complex processing task, most notably for older subjects. With an active processing task there was no significant difference between the memory performance of older and younger adults. This finding lends support to the production deficiency hypothesis of age-related memory decrements (Craik, 1984). In the present study, it was found that explicit and implicit memory performance of older adults was improved when they actively generated a sentence for each of the target words and to a lesser extent when they generated five words that began with the same letter as the target word. The slight differences in explicit memory scores between the two age groups in conceptual processing that occurred in the standard processing task were eliminated. This suggests that active generation compared to passive processing enables older adults to encode conceptually processed words more solidly and thus enhance their explicit memory performance. The act of generating enhances the processing that is being performed, whether it is perceptual or conceptual.

Rather than requiring the subject to generate the target word as the response given, which has been the normal procedure in past research (Mitchell et al., 1986; Rabinowitz, 1989; Slamecka & Graf, 1978), the present study presented the target word and asked subjects to generate words related to it in either a perceptual and conceptual manner. Only one other study has used a similar technique (Lipinska, Backman, Mantyla, & Viitanen, 1994). However, in that study, the contrast was between experimenter- and subject-generated cues. It did not study perceptual/ conceptual generation distinctions within subjects. The novel feature used in the present study is important because it allows for a teasing out of differences in generative processing conditions.

The change in processing tasks between experiments had striking effects, producing higher recognition and word fragment completion scores for each age group. This improvement in scores is brought about by the increased extensiveness of processing. When the subject is asked to generate a sentence for the word presented on the screen (conceptual processing), the word shown must be incorporated into a semantic structure that is logical and understandable. With such extensive processing, the word taps into an associative network, becomes more memorable, and is more strongly encoded than with the standard conceptual processing task of responding "Yes" or "No" to a conceptual question (e.g., Does the word refer to something that is alive?). Similarly, when the subject is asked to generate five words that begin with the same letter as the word on the screen, it is necessary to concentrate on the phonemic qualities of the words. Although this does not require the same type of cognitive elaboration as constructing a sentence, generating five words that begin with the same letter as the word on the screen results in a more memorable encoding experience than responding to a standard perceptual question (e.g., Do the following words contain the letter "e" in them?) because active generation and cognitive search are involved.

Most surprising was that the cognitively active processing task eliminated the differences in memory scores between the groups, rather than simply lessening the difference between groups, as expected. These results were found for the entire group and also after reanalysis in which subjects obtaining perfect scores were eliminated (to take into account a ceiling effect). The findings were also strengthened by the response latency data. When compared to younger adults, it appears that an increase in cognitive activation benefits older adults in both memory performance and latency to respond. It seems that differences between younger and older adults on explicit and implicit memory tests, as well as the concept of perceptual and conceptual processing, must be evaluated in terms of the cognitive demand necessary for the task.

A possibility to consider is that cognition may benefit from mental activity. Physical exercise, which requires an increase in physical demand, has been shown to improve neuropsychological function, including memory, in older adults, as measured by the Logical Memory subtest of the Wechsler Memory Test-Revised (Molloy, Beerschoten, Borrie, Crilly, & Cape, 1988). The present findings suggest that increasing cognitive demand has similar beneficial results.

There was one problem in the present work that should be addressed, the ceiling effect found in Experiment 2. Although the data were reanalyzed to exclude subjects contributing to the ceiling effect it may still be masking differences between the age groups. One possible problem that might account for this effect was the length of the study word list. The list had been used in previous work with younger adults (Grix, 1993), and no ceiling effect was found. However, future research can address this issue by lengthening the study word list or by interpolating a distractor task between study and test.

Although these data are consistent with a number of theories (Tulving & Thomson, 1973; Blaxton, 1989; Roediger & Blaxton, 1987; Roediger, Weldon, & Challis, 1989) the theory that best explains these findings is the production deficiency hypothesis (Craik, 1984). Although older adults did not benefit enough from standard processing tasks to eliminate age group differences, they showed substantial enhancement in recognition when generation was required. The act of generation seems to induce older adults to utilize their cognitive resources and enhance their memory performance. Craik (1984) has specifically stated:

> Older subjects perform certain types of mental operations inefficiently, unless the operations are induced and guided by the task, by specific instructions, or by other supportive aspects of the current environment....Older people have fewer processing resources to drive mental operations (p.10).

Although Craik contends that older people have fewer processing resources, another possibility exists. Rather than having fewer resources, as Craik suggested, the present work suggests that the processing resources may lie dormant to be utilized only with active, rather than passive, processing strategies.

According to the Moscovitch model (1989), memory involves automatic processes that occur in both the posterior and midlateral neocortex, and in the hippocampal component (the hippocampus and related limbic structures in the medial temporal lobe and diencephalon). These mechanisms are involved in consolidating, storing, and reactivating memory traces. In addition to these automatic processes, there are also strategic processes mediated by the frontal lobes. Moscovitch and Winocur (1992) have coined the phrase "working-with memory" to define the frontal lobes' function in the memory process. According to the authors:

> It ["working with memory"] is a basic feature of this structure's contribution to other behavioral processes and arises from the structure's inherent organizational and planning functions. Damage...

> leads to impairment on tests in which extra-cue organizational factors are important, in which complex search strategies must be initiated and executed, and in which retrieval information must be ordered temporally and spatially with respect to other events (p. 324).

The aspects of working-with memory that were examined in this study were 1) types of cognitive processing, in conjunction with the complexity of cognitive processing, mediated by the frontal lobes at encoding, and 2) the initiation of the additional memory search mediated by the frontal lobes at retrieval. The processing, certainly an example of working-with memory, was of critical interest in the present study.

In line with the Moscovitch model, it was hypothesized that the discrepancies in the older adults' test performance on explicit and implicit memory tests (Chiarello & Hoyer, 1988; Hamberger & Friedman, 1992; Java, 1992; Java & Gardiner, 1991; Light et al., 1992; Light & Singh, 1987; Park & Shaw, 1992) were related to frontal lobe functioning deficits that can occur in normal aging (Grady et al., 1995; Kapur et al., 1994; Paller & Kutas, 1992). Utilizing the Moscovitch terminology, working-with memory (i.e., the frontal lobe) is involved in processing at both encoding and retrieval. Therefore, the changes in the frontal lobes that occur with age could have an impact on older adults' explicit and implicit memory test performance. When processing at study involves different levels and activation of types of processing, age-related changes in frontal lobe integrity might affect the results. The correlations that were found support the involvement of the frontal lobes in memory performance when there is active generation required at encoding. The results of the present work lend support to the possibility that increased cognitive activation, and increased activation of specific brain areas, enhance memory performance.

The present conclusions are in contrast to those of Winocur et al. (1996). They found correlations between word stem completion and frontal lobe functioning but not word fragment completion and frontal lobe functioning. The authors' explanation is that word-stem completion involves a strong generative component and triggers not only perceptual identification processes but also initiates generative search processes (i.e., frontal lobe involvement). Word fragment completion does not. Their argument is that word fragment completion is a "perceptual identification test in which the fragment evokes the perceptual record of the target" (p. 62). This explanation is in contrast to the findings of Weldon (1993) regarding the conceptual component of word fragment completion, and to the findings of the present study, which did find correlations between word fragment completion and frontal lobe tests when a more cognitively complex processing task was involved. This type of processing was not used in the Winocur et al. (1996) study.

Rather than finding the expected deficit for older adults as a result of a documented decline in the structure of the frontal lobes in that group (Coffey et al., 1992), as well as documentation of inferior frontal lobe functioning for older adults compared to younger adults (Mittenberg et al., 1989; Craik et al., 1990; Kopelman, 1991; Libon et al., 1994), the present research has arrived at a complex picture of what occurs in the working-with memory/memory performance of older adults.

A possibility to consider here is that the functioning of the frontal lobes at encoding and retrieval may affect the memory performance of younger and older adults differentially. When different levels and extensiveness of perceptual and conceptual processing are utilized at encoding and retrieval, we must consider whether age-related changes in frontal lobe integrity, as measured by frontal lobe functioning tests, are related to results on explicit and implicit memory tests.

According to Schacter (1996):

> Difficulties related to the frontal lobes emerge as the most important factor in elderly adults' impaired cognitive performance on several different tests....Rather than resulting from a general decline in all aspects of brain function, many memory problems in older adults may stem from specific impairments in the frontal lobes (pp. 286-287).

With a standard levels of processing task no correlations were found between the scores on the explicit and implicit memory tests and the frontal lobe functioning tests for either group. It could not be stated, therefore, that the differences that were found between the groups on the explicit and implicit memory tests were related to frontal lobe functioning. What could be said, as has been noted for many years, is that there are differences between the groups, particularly on an explicit memory test, when perceptual and conceptual processing are the variables of interest (Howard, 1988; Light, 1988). However, with an increase in cognitive activation, while maintaining the perceptual/conceptual distinction, the results were different. What is most interesting about the results when increased cognitive activation is utilized are the facts that the memory differences between the groups were eliminated and when this difference was eliminated, the significant correlations occurred with the implicit memory test. Moscovitch and Winocur (1992) have suggested that the working-with-memory function of the frontal lobes "may be necessary for the organization of unconscious memory processes that drive performance on implicit tests of memory" (p. 324). In the present study, it appears that this is the case for both the older and younger adults. The possibility exists that older adults, more than younger adults, must rely on the posterior brain areas to retrieve information that is stored in those particular areas (i.e., for implicit memory performance). Consequently, the activation of the posterior areas of the brain - which then interact with the activated frontal lobes - allow the retrieval of the stored information to occur more readily than with passive tasks. This results in higher memory scores on both explicit and implicit memory tests and positive correlations with the frontal lobe functioning tests. The possibility also exists that, during memory tests, younger adults may be utilizing brain areas that are less structurally compromised than those of the older adults (i.e., the hippocampus and related structures) when retrieving information that is in storage. Therefore, their memory performance does not hinge upon this type of activation to the extent that the older group's performance does.

Although Nyberg et al's., (1997) discussion focused on word stem completion rather than word fragment completion, they have suggested that the frontal lobes may be necessary for establishing priorities for response selection, based on levels of activation [italics added]. In the present study, the increase in cognitive demand at study appears to have resulted in increased levels of activation that have strengthened the encoding and retrieval processes in both the explicit and implicit memory tests.

Structural changes in other brain areas of older adults do not occur at the same rate as in the frontal lobes (Coffey et al., 1992). Despite the fact that the Word Fragment Completion Test does have conceptual components (Weldon, 1993), it is considered to be a more perceptually driven test. Since long-term perceptual and semantic records of input and their interpretation are stored in specialized cortical structures (Kirsner & Dunn, 1985) and these areas of the brain are changed less than the frontal lobes in the elderly, it is suggested that these areas are more involved in implicit memory tests and therefore contribute not only to implicit memory test performance, but also to the correlations between those tests and the frontal lobe functioning tests in this study.

Schacter (1996) has stated that "the implicit form of memory...generally holds up well as we age" (p. 291). In the present study, it appears that the increase in activation at encoding has activated the frontal lobes to a greater degree than the more passive task of responding Yes/No to presented questions. This frontal lobe activation in turn may have increased neuronal firing in the more posterior areas of the brain that are known to remain more intact in older adults (Coffey et al, 1992). It has also been proposed that these posterior areas are the storage sites for implicit memories (Schacter, 1996) and that implicit memory does in fact affect explicit memory performance (Winocur et al., 1996). Based on the present findings, this appears to be what is occurring in this study. Follow-up research utilizing an ERP or neuroimaging technique would bolster the accuracy of this conclusion.

The present work did not find a correlation of the explicit memory test results with the frontal lobe functioning test results, which is in contrast to previous work (Nyberg et al., 1997). Perceptual and conceptual processing were not the focus of the Nyberg et al. study and this might partially account for the differences in results. As stated above, it has been suggested that implicit memory does affect explicit memory performance (Winocur et al., 1996). If that is the case, the possibility exists that the increased activation in the frontal lobes at encoding and retrieval, as well as its relation to the implicit memory test, has benefited the explicit memory test as well.

To summarize, this study has shown that when a standard levels of processing task is utilized there are differences in performance between younger and older adults on explicit and implicit memory tests and there appears to be no relationship between frontal lobe functioning and memory test performance. However, when a levels of processing task is maintained and cognitive demand (brain activation) is increased, the differences between the groups are eliminated. It appears that this increase in frontal lobe activation as measured by frontal lobe functioning tests is related to memory test performance. This interpretation does not contradict the production deficiency hypothesis of Craik (1984). Rather, it enhances it by providing support for specific brain regions relating to certain behaviors. Keane, Gabrieli, Monti, Fleischman, Cantor, and Noland (1997) have stated that "perceptual and conceptual processing does not accurately capture spared and impaired memory function...[as well as]...the inadequacy of an implicit-explicit memory dichotomy" (pp. 67-68). This statement is consistent with the present findings.

The process is much more complex. Although older adults have been shown to have deterioration in frontal lobe structures (Coffey et al., 1992), memory performance of older adults can be enhanced with appropriate encoding tasks. Future research will address the issue of cognitively active processing tasks and the possibility of their use in applied cognitive aging research.

APPENDIX A

BACKGROUND QUESTIONNAIRE

SUBJECT I.D. No. ________________

1. Age: ______________________________

2. Sex: Male ______ Female ______

3. State the number of years of education completed and degree(s) held, if any:

____

4. I consider myself to be in:

1 - Very good health ____________
2 - Good health ____________
3 - Fair health ____________
4 - Poor health ____________
5 - Very poor health ____________

5. I consider myself to be:

1 - Very Active ____________
2 - Active ____________
3 - Fairly Active ____________
4 - Not Active ____________

6. I smoke: Yes _____ No _____
If yes, how much? ________________

7. I drink: Yes _____ No _____
If yes, how often and how many drinks? _________

8. I have a history of head injury:

Yes _____ No _____
If Yes, please
explain: _______________________________________
____

9. I have/had epilepsy (convulsions):

Yes _____ No _____
If YES, please
explain: _____________________________________
____

10. I have/had a neurological disease (e.g., Stroke, Multiple Sclerosis, Parkinson's Disease, etc.):

Yes _____ No_____
If Yes, please
explain:_______________________________________
____

11. I have/had a history of substance abuse (e.g., alcohol or drugs)

Yes _____ No ______
If Yes, please
explain:____
____

12. Check the appropriate column (YES or NO) for any medications listed below that you are taking:

	YES	NO
High Blood Pressure	_____	_____
Diabetes	_____	_____
Heart Condition	_____	_____
Depression	_____	_____
Anxiety	_____	_____

Other (please state medication):
____

For any medication checked "YES" above, please state name of medication and dosage:
____

____

____

APPENDIX B

Target Words and Word Fragment Completions to be used in Experiment 1. Word numbers 1 through 64 compose List 1; Word numbers 65 through 128 compose List 2.

1,ATTENDANT, A-T-N-A-T
2,BUTCHER, B-T-H-R
3,ELEPHANT, E-E-H-N-
4,FRIEND, F-I-N-
5,JUGGLER, J-G-L-R
6,LOBSTER, L-B-T-R
7,PERFORMER, P-R-O-M-R
8,SINGER, S-N-E-
9,ANIMAL, A-I-A-
10,ARTIST, A-T-S-
11,BUSYBODY, B-S-B-D-
12,DOORMAN, D-O-M-N
13,MONARCH, M-N-R-H
14,MUSICIAN, M-S-C-A-
15,PIANIST, P-A-I-T
16,TROOPS, T-O-P-
17,BAGPIPE, B-G-I-E
18,BUTTER, B-T-E-
19,DAYBREAK, D-Y-R-A-
20,HEADLIGHT, H-A-L-G-T
21,NUTMEG, N-T-E-
22,SCIENCE, S-I-N-E
23,TWEEZERS, T-E-Z-R-
24,VESTIBULE, V-S-I-U-E
25,ALCOHOL, A-C-H-L
26,DAYLIGHT, D-Y-I-H-
27,GALAXY, G-L-X-
28,PRISON, P-I-O-
29,PUDDING, P-D-I-G
30,RHAPSODY, R-A-S-D-
31,SAILBOAT, S-I-B-A-
32,WINDMILL, W-N-M-L-
33,BACTERIA, B-C-E-I-
34,CREATURE, C-E-T-R-
35,FISHERMAN, F-S-E-M-N
36,GENTLEMAN, G-N-L-M-N
37,LEOPARD, L-O-A-D
38,MAIDEN, M-I-E-
39,PRISONER, P-I-O-E-
40,TEACHER, T-A-H-R
41,ADMIRAL, A-M-R-L
42,ARMADILLO, A-M-D-L-O
43,AUTHOR, A-T-O-
44,CHARLATAN, C-A-L-T-N
45,INFANT, I-F-N-
46,MOSQUITO, M-S-U-T-

47,PHYSICIAN, P-Y-I-I-N
48,SOCIALIST, S-C-A-I-T
49,BARREL, B-R-E-
50,CEREMONY, C-R-M-N-
51,FURNITURE, F-R-I-U-E
52,MAGAZINE, M-G-Z-N-
53,PICTURE, P-C-U-E
54,SEASHORE, S-A-H-R-
55,UMBRELLA, U-B-E-L-
56,WINTER, W-N-E-
57,ACCORDION, A-C-R-I-N
58,BUILDING, B-I-D-N-
59,DIAMOND, D-A-O-D
60,LABYRINTH, L-B-R-N-H
61,PROMOTION, P-O-O-I-N
62,RAILROAD, R-I-R-A-
63,SHADOW, S-A-O-
64,SPINACH, S-I-A-H

65,BANKER, B-N-E-
66,BUTTERFLY, B-T-E-F-Y
67,CATTLE, C-T-L-
68,DERELICT, D-R-L-C-
69,HENCHMAN, H-N-H-A-
70,PERSON, P-R-O-
71,PROFESSOR, P-O-E-S-R
72,SETTLER, S-T-L-R
73,ALLIGATOR, A-L-G-T-R
74,BLOSSOM, B-O-S-M
75,DOCTOR, D-C-O-
76,GLUTTON, G-U-T-N
77,OCTOPUS, O-T-P-S
78,PYTHON, P-T-O-
79,SCORPION, S-O-P-O-
80,VICTIM, V-C-I-
81,AGREEMENT, A-R-E-E-T
82,CELLAR, C-L-A-
83,COFFEE, C-F-E-
84,ECONOMY, E-O-O-Y
85,MATERIAL, M-T-R-A-
86,MOISTURE, M-I-T-R-
87,PREVIEW, P-E-I-W
88,VILLAGE, V-L-A-E
89,CARAVAN, C-R-V-N
90,COLONY, C-L-N-
91,HAIRPIN, H-I-P-N
92,HISTORY, H-S-O-Y
93,JOURNAL, J-U-N-L
94,PORTRAIT, P-R-R-I-
95,SONATA, S-N-T-
96,VOCATION, V-C-T-O-
97,BUILDER, B-I-D-R

98,CANDIDATE, C-N-I-A-E
99,CREATOR, C-E-T-R
100,DREAMER, D-E-M-R
101,LECTURER, L-C-U-E-
102,POLICEMAN, P-L-C-M-N
103,RETAILER, R-T-I-E-
104,STUDENT, S-U-E-T
105,ACROBAT, A-R-B-T
106,BANDIT, B-N-I-
107,BUFFOON, B-F-O-N
108,GADFLY, G-D-L-
109,MAMMAL, M-M-A-
110,PHANTOM, P-A-T-M
111,SAVANT, S-V-N-
112,SULTAN, S-L-A-
113,APPLIANCE, A-P-I-N-E
114,CHLORIDE, C-L-R-D-
115,CUISINE, C-I-I-E
116,LANDSCAPE, L-N-S-A-E
117,MIRAGE, M-R-G-
118,OXYGEN, O-Y-E-
119,TRELLIS, T-E-L-S
120,WHISKERS, W-I-K-R-
121,BUNGALOW, B-N-A-O-
122,CLOTHING, C-O-H-N-
123,COURTSHIP, C-U-T-H-P
124,HALLWAY, H-L-W-Y
125,HOSPITAL, H-S-I-A-
126,MOUNTAIN, M-U-T-I-
127,RITUAL, R-T-A-
128,SULPHUR, S-L-H-R

Appendix C

Written Consent Form A - Experiment 1

Name of Research Supervisor/Sponsor: Dr. Wilma Winnick

Principal Investigator: Maureen C. Grix, M.A., M.Phil.

Departmental Affiliation with Queens College: Psychology

Title of Project: Perceptual and Conceptual Processing in Younger & Older Adults

Date of Approval from Queens College Institutional Committee for the Protection of Human Subjects: May 3, 1995

The purpose of this study is to determine any differences in the processing of words in healthy young adults (18-35 year olds) vs healthy older adults (70-89 year olds).

First, I will be asked to fill out a short background and health questionnaire to determine if I am in good health. My name will not be on the questionnaire. My responses to these questions will be coded by number and will in no way violate the confidentiality of my participation in this research. Second, I will be asked eleven questions, which will take 5-10 minutes to answer. Third, I will be asked to perform a number of simple computer tasks which will involve looking at words presented one at a time on the computer screen and then pressing a key (or keys) on the computer keyboard in response to the words. Fourth, I will be asked to verbally define a number of words. Lastly, I will be given two simple verbal tasks (saying words aloud) that will take a total of five minutes. The results of the research will be coded by number and will be kept in the Principal Investigator's locked file.

There are no risks associated with my participation in this research. The benefit I will derive from my participation in this research is that I am helping to advance the knowledge in the area of neuropsychology.

The investigator has explained my rights to me as a research subject. I understand that if I feel uncomfortable with any procedure at any time I am free to withdraw without any consequence upon my standing at Queens College (grades, course requirements, job status, or any other institutional privilege or responsibility). If I have any questions about the study, I can contact:

Dr. Wilma Winnick and/or
Maureen C. Grix, M.A., M.Phil.
Queens College Psychology Department

Telephone #718-997-3201 (Dr. Wilma Winnick - Office)

or

718-997-3251 (Cognitive Neuropsychology Lab)

or

718-575-3824 (M. Grix - Answering Machine)

I understand that my anonymity and confidentiality will be preserved wherever possible and have been informed about the procedures taken to assure confidentiality. Once my participation is over, there will be no records that will connect my identity with specific data or results.

My signature below indicates that I have read and understood this Consent Form and been fully informed as to the nature of this research that I agree to participate in. I understand my participation is fully voluntary and am free to withdraw at any time.

I consent to the retention of information gathered during this study to the publication of results based on that information given the assurance that my anonymity and confidentiality are preserved.

I have a right to a copy of this consent form and may inspect a copy of the Institutional Assurance for the Protection of Human Subjects filed by the Research Foundation of CUNY with the U.S. Department of Health and Human Services.

Participant's Signature:

____

Participant's Name (print or type):

____

Researcher/Investigator's Signature:

____

Researcher/Investigator's Name: Maureen C. Grix

Date__________________________ New York City, New York

Appendix D

Written Consent Form B - Experiment 1

Name of Research Supervisor/Sponsor: Dr. Wilma Winnick

Principal Investigator: Maureen C. Grix, M.A., M.Phil.

Departmental Affiliation with Queens College: Psychology

Title of Project: Perceptual and Conceptual Processing in Younger & Older Adults

Date of Approval from Queens College Institutional Committee for the Protection of Human Subjects: May 3, 1995

The purpose of this study is to determine any differences in the processing of words in healthy young adults (18-35 year olds) vs healthy older adults (70-85 year olds).

First, I will be asked to fill out a short background and health questionnaire to determine if I am in good health. My name will not be on the questionnaire. My responses to these questions will be coded by number and will in no way violate the confidentiality of my participation in this research. Second, I will be asked to perform a number of simple computer tasks which will involve looking at words presented one at a time on the computer screen and then pressing a key (or keys) on the computer keyboard in response to the words. Third, I will be asked to verbally define a number of words. Fourth, I will be given two simple verbal tasks (saying words aloud) that will take a total of five minutes. The results of the research will be coded by number and will be kept in the Principal Investigator's locked file.

There are no risks associated with my participation in this research. The benefit I will derive from my participation in this research is that I am helping to advance the knowledge in the area of neuropsychology.

The investigator has explained my rights to me as a research subject. I understand that if I feel uncomfortable with any procedure at any time I am free to withdraw without any consequence upon my standing at Queens College (grades, course requirements, job status, or any other institutional privilege or responsibility). If I have any questions about the study, I can contact:

Dr. Wilma Winnick and/or
Maureen C. Grix, M.A., M.Phil.
Queens College Psychology Department

Telephone #718-997-3201 (Dr. Wilma Winnick - Office)
or
718-997-3251 (Cognitive Neuropsychology Lab)
or
718-575-3824 (M. Grix - Answering Machine)

I understand that my anonymity and confidentiality will be preserved wherever possible and have been informed about the procedures taken to assure confidentiality. Once my participation is over, there will be no records that will connect my identity with specific data or results.

My signature below indicates that I have read and understood this Consent Form and been fully informed as to the nature of this research that I agree to participate in. I understand my participation is fully voluntary and am free to withdraw at any time.

I consent to the retention of information gathered during this study to the publication of results based on that information given the assurance that my anonymity and confidentiality are preserved.

I have a right to a copy of this consent form and may inspect a copy of the Institutional Assurance for the Protection of Human Subjects filed by the Research Foundation of CUNY with the U.S. Department of Health and Human Services.

Participant's Signature:

____

Participant's Name (print or type):

____

Researcher/Investigator's Signature:

____

Researcher/Investigator's Name: Maureen C. Grix

Date___________________________ New York City, New York

APPENDIX E

Target Words and Word Fragment Completions to be used in Experiment 2. Word numbers 1 through 48 compose List 1; Word numbers 49 through 96 compose List 2.

1, AIRPLANE, A_R_L_N_
2, ANCHOR, A_C_O_
3, APARTMENT, A_A_T_E_T
4, BALLOON, B_L_O_
5, BANISTER, B_N_S_E_
6, BARBECUE, B_R_E_U_
7, BASEMENT, B_S_M_N_
8, CABINET, C_B_N_T
9, CALORIES, C_L_R_E_
10, CANDLE, C_N_L_
11, CHAMPAGNE, C_A_P_G_E
12, CHILDREN, C_I_D_E_
13, COMPASS, C_M_A_S
14, CORPORAL, C_R_O_A_
15, COLUMN, C_L_M_
16, CONTRACT, C_N_R_C_
17, DEFENDANT, D_F_N_A_T
18, DINOSAUR, D_N_S_U_
19, DOLLARS, D_L_A_S
20, ELEVATOR, E_E_A_O_
21, FACTORY, F_C_O_Y
22, FIREPLACE, F_R_P_A_E
23, FURNITURE, F_R_I_U_E
24, GARLIC, G_R_I_
25, HARVEST, H_R_E_T
26, HIGHWAY, H_G_W_Y
27, HURRICANE, H_R_I_A_E
28, LEAFLET, L_A_L_T
29, LIMERICK, L_M_R_C_
30, LINOLEUM, L_N_L_U_
31, MALARIA, M_L_R_A
32, MIDNIGHT, M_D_I_H_
33, MONKEY, M_N_E_
34, MUSEUM, M_S_U_
35, NECKTIE, N_C_T_E
36, OUTFIELD, O_T_I_L_
37, OVERALLS, O_E_A_L_
38, PALACE, P_L_C_
39, PASSPORT, P_S_P_R_
40, PERISCOPE, P_R_S_O_E
41, SENATOR, S_N_T_R
42, SUNSET, S_N_E_
43, TOMATOES, T_M_T_E_
44, TRAPEZE, T_A_E_E
45, TRIPOD, T_I_O_
46, TROUSERS, T_O_S_R_
47, VOLCANO, V_L_A_O

48, WATERFALL, W_T_R_A_L

49, ACCORDION, A_C_R_I_N
50, ADMIRAL, A_M_R_L
51, AMBULANCE, A_B_L_N_E
52, ATTORNEY, A_T_R_E_
53, BEAVER, B_A_E_
54, BLOSSOM, B_O_S_M
55, BULLET, B_L_E_
56, CASEMENT, C_S_M_N_
57, CLOTHING, C_O_H_N_
58, COSTUME, C_S_U_E
59, COUNTER, C_U_T_R
60, CRADLE, C_A_L_
61, DECEIT, D_C_I_
62, DESSERT, D_S_E_T
63, DISTANCE, D_S_A_C_
64, EMBASSY, E_B_S_Y
65, EMPORIUM, E_P_R_U_
66, FLANNEL, F_A_N_L
67, FLOWER, F_O_E_
68, GENDER, G_N_E_
69, GLACIER, G_A_I_R
70, GRAVITY, G_A_I_Y
71, LANGUAGE, L_N_U_G_
72, MAGAZINE, M_G_Z_N_
73, MARKET, M_R_E_
74, MILEAGE, M_L_A_E
75, MINISTER, M_N_S_E_
76, MIRACLE, M_R_C_E
77, PACKAGE, P_C_A_E
78, PAINTER, P_I_T_R
79, PARACHUTE, P_R_C_U_E
80, PORTRAIT, P_R_R_I_
81, PRETZEL, P_E_Z_L
82, REACTION, R_A_T_O_
83, REPORTER, R_P_R_E_
84, SANDWICH, S_N_W_C_
85, SCAFFOLD, S_A_F_L_
86, SKILLET, S_I_L_T
87, SLIPPER, S_I_P_R
88, SNOWMAN, S_O_M_N
89, STAIRCASE, S_A_R_A_E
90, STUDENT, S_U_E_T
91, TEACHER, T_A_H_R
92, TRELLIS, T_E_L_S
93, TRUMPET, T_U_P_T
94, TURTLE, T_R_L_
95, WHISTLE, W_I_T_E
96, WINDOW, W_N_O_

Appendix F

Written Consent Form A - Experiment 2

Name of Research Supervisor/Sponsor: Dr. Wilma Winnick

Principal Investigator: Maureen C. Grix, M.A., M.Phil.

Departmental Affiliation with Queens College: Psychology

Title of Project: Perceptual and Conceptual Processing in Younger & Older Adults

Date of Approval from Queens College Institutional Committee for the Protection of Human Subjects: September 1, 1996

The purpose of this study is to determine any differences in the processing of words in healthy young adults (18-35 year olds) vs healthy older adults (70-89 year olds).

First, I will be asked to fill out a short background and health questionnaire to determine if I am in good health. My name will not be on the questionnaire. My responses to these questions will be coded by number and will in no way violate the confidentiality of my participation in this research. Second, I will be asked eleven questions, which will take 5-10 minutes to answer. Third, I will be asked to perform a number of simple computer tasks which will involve looking at words presented one at a time on the computer screen and saying aloud a sentence or five words having to do with the word on the screen. My responses to the words presented on the computer screen will be tape recorded. Fourth, I will press a key (or keys) on the computer keyboard in response to words. Fifth, I will be asked to verbally define a number of words. Lastly, I will be given two simple verbal tasks (saying words aloud) that will take a total of five minutes. The results of the research will be coded by number and will be kept in the Principal Investigator's locked file.

There are no risks associated with my participation in this research. The benefit I will derive from my participation in this research is that I am helping to advance the knowledge in the area of neuropsychology.

The investigator has explained my rights to me as a research subject. I understand that if I feel uncomfortable with any procedure at any time I am free to withdraw without any consequence upon my standing at Queens College (grades, course requirements, job status, or any other institutional privilege or responsibility). If I have any questions about the study, I can contact:

Dr. Wilma Winnick and/or
Maureen C. Grix, M.A., M.Phil.
Queens College Psychology Department
Telephone #718-997-3201 (Dr. Wilma Winnick - Office)
or
718-997-3251 (Cognitive Neuropsychology Lab)
or
718-575-3824 (M. Grix - Answering Machine)

I understand that my anonymity and confidentiality will be preserved wherever possible and have been informed about the procedures taken to assure confidentiality. Once my participation is over, there will be no records that will connect my identity with specific data or results.

My signature below indicates that I have read and understood this Consent Form and been fully informed as to the nature of this research that I agree to participate in. I understand my participation is fully voluntary and am free to withdraw at any time.

I consent to the retention of information gathered during this study to the publication of results based on that information given the assurance that my anonymity and confidentiality are preserved.

I have a right to a copy of this consent form and may inspect a copy of the Institutional Assurance for the Protection of Human Subjects filed by the Research Foundation of CUNY with the U.S. Department of Health and Human Services.

Participant's Signature:

____

Participant's Name (print or type):

____

Researcher/Investigator's Signature:

____

Researcher/Investigator's Name: Maureen C. Grix

Date___________________________ New York City, New York

Appendix G

Written Consent Form B - Experiment 2

Name of Research Supervisor/Sponsor: Dr. Wilma Winnick

Principal Investigator: Maureen C. Grix, M.A., M.Phil.

Departmental Affiliation with Queens College: Psychology

Title of Project: Perceptual and Conceptual Processing in Younger & Older Adults

Date of Approval from Queens College Institutional Committee for the Protection of Human Subjects: September 1, 1996

The purpose of this study is to determine any differences in the processing of words in healthy young adults (18-35 year olds) vs healthy older adults (70-89 year olds).

First, I will be asked to fill out a short background and health questionnaire to determine if I am in good health. My name will not be on the questionnaire. My responses to these questions will be coded by number and will in no way violate the confidentiality of my participation in this research. Second, I will be asked to perform a number of simple computer tasks which will involve looking at words presented one at a time on the computer screen and saying aloud a sentence or five words having to do with the word on the screen. My oral responses to the words presented on the computer screen will be tape recorded. Third, I press a key (or keys) on the computer keyboard in response to words. Fourth, I will be asked to verbally define a number of words. Lastly, I will be given two simple verbal tasks (saying words aloud) that will take a total of five minutes. The results of the research will be coded by number and will be kept in the Principal Investigator's locked file.

There are no risks associated with my participation in this research. The benefit I will derive from my participation in this research is that I am helping to advance the knowledge in the area of neuropsychology.

The investigator has explained my rights to me as a research subject. I understand that if I feel uncomfortable with any procedure at any time I am free to withdraw without any consequence upon my standing at Queens College (grades, course requirements, job status, or any other institutional privilege or responsibility). If I have any questions about the study, I can contact:

Dr. Wilma Winnick and/or
Maureen C. Grix, M.A., M.Phil.

Queens College Psychology Department

Telephone #718-997-3201 (Dr. Wilma Winnick - Office)
or
718-997-3251 (Cognitive Neuropsychology Lab)
or
718-575-3824 (M. Grix - Answering Machine)

I understand that my anonymity and confidentiality will be preserved wherever possible and have been informed about the procedures taken to assure confidentiality. Once my participation is over, there will be no records that will connect my identity with specific data or results.

My signature below indicates that I have read and understood this Consent Form and been fully informed as to the nature of this research that I agree to participate in. I understand my participation is fully voluntary and am free to withdraw at any time.

I consent to the retention of information gathered during this study to the publication of results based on that information given the assurance that my anonymity and confidentiality are preserved.

I have a right to a copy of this consent form and may inspect a copy of the Institutional Assurance for the Protection of Human Subjects filed by the Research Foundation of CUNY with the U.S. Department of Health and Human Services.

Participant's Signature:

____

Participant's Name (print or type):

____

Researcher/Investigator's Signature:

____

Researcher/Investigator's Name: Maureen C. Grix

Date__________________________ New York City, New York

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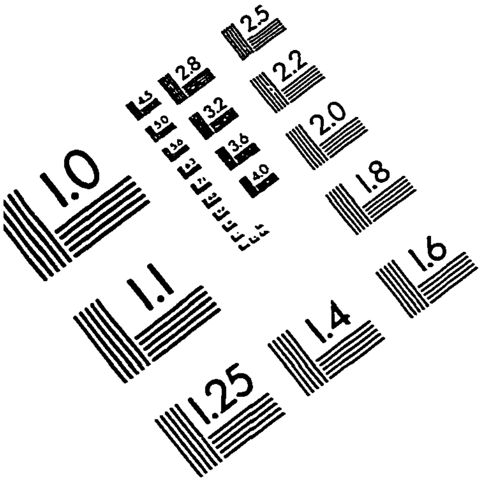
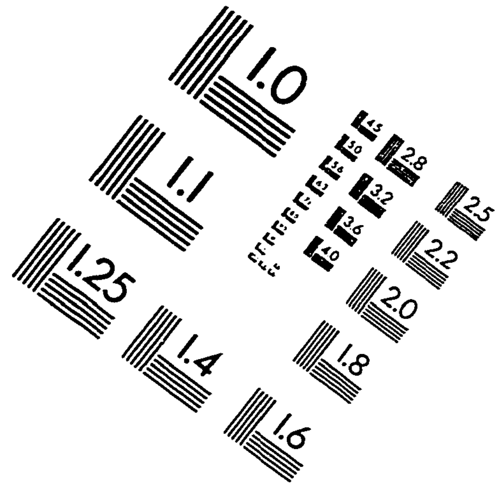
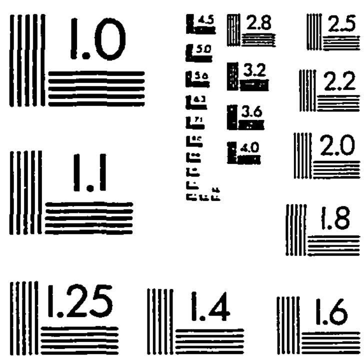
IMAGE EVALUATION TEST TARGET (QA-3)







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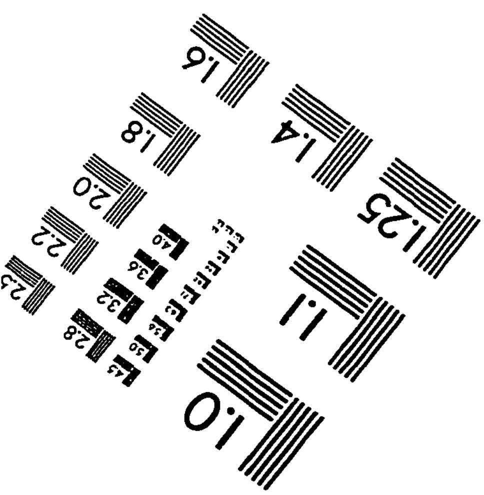

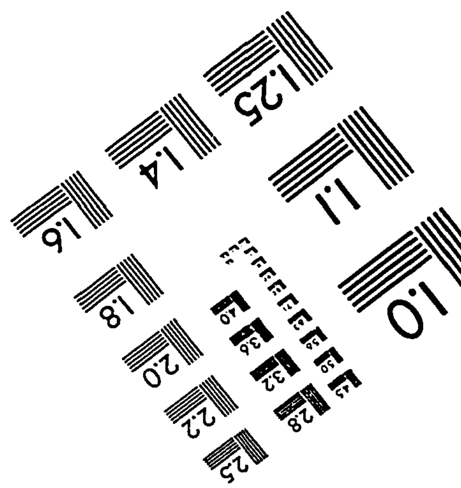

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