Longitudinal Changes in Semantic Memory Performance of Older Adults

by

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Abstract

Longitudinal changes in semantic memory performance of older adults were examined. Participants, drawn from the Victoria Longitudinal Study, consisted of 81 Young-Old ($\underline{M}_{T1}$ = 62.89, range = 54 to 67 years) and 43 Old-Old ($\underline{M}_{T1}$ = 71.28, range = 68 to 82 years) adults tested 5 times at 3-year intervals. Performance was indexed by measures of vocabulary, fact recall, 3 indicators of verbal fluency (opposites, similarities, figures of speech), and 2 indicators of verbal speed (semantic verification, lexical decision). Performance at time 1 was compared to 100 Young adults ($\underline{M}_{T1}$ = 24.77, range = 19 to 36 years). The 2 older age groups performed similarly; however, age differences were observed between Young adults and older adults on all but opposites and similarities. Longitudinal results indicated modest but significant decline across 5 occasions for all tasks. There were interactions for fact recall, figures of speech, semantic verification, and lexical decision, showing more rapid decline for Old-Old adults.

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Dedication

For Jacob, "my little angel". You will always hold a special place in my heart.

Longitudinal Changes in Semantic Memory Performance of Older Adults

"Les souvenirs sont cors de chasse / Dont meurt le bruit parmi le vent. – Memories are hunting-horns, whose noise dies away in the wind."

GUILLAUME APOLLINAIRE – Cors de Chasse

CHAPTER 1

It is generally accepted that memory decline is an inevitable consequence of the aging process. This belief is supported by observations that older adults report experiencing more memory problems in everyday life (e.g., Smith, Petersen, Ivnik, Malec, & Tangalos, 1996) and perform more poorly on a wide variety of memory tests (see Craik & Jennings, 1992; Kausler, 1994, for reviews) than younger adults. There are multiple systems of memory (Tulving, 1972, 1985), however, and not all systems exhibit identical patterns of age-related changes. For example, although performance on tasks measuring episodic memory shows steady but moderate decline with age (Small, Dixon, Hultsch, & Hertzog, 1999), performance on semantic memory tasks appears to be maintained across adulthood (Nilsson et al., 1997). When observed, age differences in indicators of semantic memory have been small and often highly selective (Bäckman, Small, Wahlin, & Larsson, 2000).

Semantic memory has been defined as the memory store for facts, ideas, and concepts that are retained without reference to the temporal or spatial contexts present at the time of storage (Kausler, 1994). It differs from episodic memory, which is tied to temporal and spatial contexts of past experiences. Knowledge that is represented independently of the acquisition context has the benefit of gaining savings in storage (Camp, 1989). This savings can be translated into rapid and seemingly effortless access at subsequent retrieval. Even with large deficits in other types of memory (e.g., episodic memory), a relatively intact semantic memory system would mean that an individual could still make sense of the world and engage in meaningful conversation with those around them.

Most often, semantic memory has been indexed by measures of vocabulary and general world knowledge. In addition to these classic tasks, verbal fluency measures and semantic and lexical decision tasks have also been used. Each task may tap a different aspect of semantic memory. Research examining performance on each type of semantic memory task across the lifespan indicates slightly varying patterns of age-related differences. For some tasks (e.g., standard vocabulary tests), older adults perform at similar or moderately higher levels than younger adults (Berkowitz, 1953; Bowles & Poon, 1985; Mitchell, 1989; Schaie & Willis, 1993; Stones, 1978). For other tasks (e.g., reverse vocabulary tests), older adults perform at slightly lower levels than younger adults (Bäckman & Nilsson, 1996; Botwinick & Storandt, 1974; Bowles & Poon, 1985; Stones, 1978). These variations appear to be dependent on task complexity and on inclusion of very old adults in research samples (Bäckman & Nilsson, 1996). The more complex the task and the older the sample, the greater the age differences.

The majority of studies examining semantic memory performance in adulthood have been cross-sectional. Conclusions drawn from these studies must recognize that "differences" found between age groups in semantic memory performance may be confounded with cohort-related factors, such as differences in educational level, rather than representing "true" change in semantic memory ability itself. In addition, semantic memory has seldom been the focus of research. Typically, semantic memory has been studied within the context of other memory systems (e.g., episodic memory) (e.g., Bäckman et al., 2000; Craik & Jennings, 1992; Hultsch, Hertzog, Dixon, & Small, 1998; Mitchell, 1989; Nyberg, 1994; Smith, 1996) or as a background indicator of general knowledge much like subjective health or education. When it has been the research focus, most often a single semantic task or ability (e.g., vocabulary, name recall) (e.g., Albert, Heller, & Milberg, 1988; Burke & Laver, 1990; Crook & West, 1990) has been examined. A notable exception is a study by Bäckman and Nilsson (1996) which examined performance on several semantic memory measures across the adult life span. This study, however, was confined to cross-sectional analyses which, as noted above, cannot speak to change in performance with increasing age. More evidence is needed regarding the specific nature and scope of semantic memory changes associated with normal aging.

The purpose of the present research was to extend existing knowledge concerning semantic memory performance. Specifically, the following issues were addressed: (a) What are the patterns of age-related change associated with multiple indicators of semantic memory in a group of older adults, and (b) how do these patterns compare to findings from cross-sectional analyses.

CHAPTER 2

Review of the Literature

Tulving's Five System Model of Memory

The memory classification scheme proposed by Tulving (1972, 1985) has had a considerable impact on memory research. In his original formulation, Tulving (1972) argued for a long-term memory store (LTS) that had three distinct components: episodic, semantic, and procedural. Episodic memory referred to autobiographical records of past experiences. Semantic memory referred to knowledge of language, rules, and concepts. Procedural memory referred to memory for skills. Both episodic and semantic memory could be consciously accessed whereas procedural memory was consciously inaccessible. Tulving (1985) later expanded his account broadening the definition of semantic memory and adding two further memory systems (perceptual representation memory and short-term memory). Tulving (1972) initially described semantic memory as a repository of fixed knowledge of the world that an individual shares with others. This was redefined as memory that allows an individual to mentally reproduce objects, situations, facts, and events. This revised view allowed for storage of the memory of an event without personal reference information (i.e., information about the temporal and spatial context present at the time of storage). Access to the memory could then be gained more rapidly and effortlessly.

According to Tulving (1985), these five memory systems are functionally distinct although they are also interactive. For example, knowledge is initially acquired through an experience or learning event; however, it is not always necessary to retain in memory the event itself (i.e., the episodic record). Over time, an item of knowledge may be encountered with sufficient frequency that memory for the learning event is forgotten and the knowledge then becomes part of the semantic memory system (Camp, 1989; Hultsch et al., 1998).

Semantic Memory and Aging

Some support for Tulving's assertion that semantic memory and episodic memory represent separate memory systems comes from evidence that the pattern of age differences found for semantic memory tasks do not mimic the pattern of age differences found for episodic memory tasks (Mitchell, 1989). In contrast to the pronounced age differences commonly found for episodic memory tasks (see Burke & MacKay, 1997, for a review), the dominant pattern for semantic memory tasks is small age differences that are highly selective and often negligible (Craik & Jennings, 1992; Kausler, 1994). Most of the early work on semantic memory and aging supported this contention and indicated relative stability of performance across the life span. More recent studies, however, have observed a number of age-related decrements on semantic memory tasks (e.g., Hultsch & Dixon, 1990). These age-related differences appear to be dependent on the type of task being examined as well as on the age range of the groups being compared (Bäckman & Nilsson, 1996).

Vocabulary

Memory for words and the concepts they represent as assessed by vocabulary tests is the component of semantic memory that has most often been examined by both memory and aging researchers (Kausler, 1994). Most often, non-significant or modest age differences favouring older adults have been found on vocabulary measures. Berkowitz (1953) observed that adults in their 60s and 70s attained scores comparable to adults in their 20s and 30s on the vocabulary subtest of the Wechsler Adult Intelligence Scale (WAIS). Others (Giambra, Arenberg, Kawas, Zonderman, and Costa, 1995; Gilinsky and Judd, 1994) have reported increases in vocabulary scores up to the 40s and then stability of scores until very old age (i.e., greater than 80 years old). Bäckman and Nilsson (1996) reported similar performance for adults aged 35 to 50 but noted a roughly linear decrease in performance across age groups thereafter. Cross-sectional evidence from the Seattle Longitudinal Study (SLS: Schaie, 1994) indicated that vocabulary peaked in midlife and then began to show negative age differences by early old age. However, longitudinal results indicated increases in vocabulary scores up to approximately 53 years of age and very little decrement occurring in performance thereafter until the seventh decade.

One factor that needs to be taken into account when measuring vocabulary in adults is the educational level of the participants in the sample. Vocabulary scores and educational level are known to be highly correlated and, moreover, older adults tend to have less formal education than younger adults (Kausler, 1994). Matching samples of older and younger adults on education has generally indicated superior vocabulary scores for older adults (Kausler, 1994). The older adults in the Berkowitz (1953) study had less education than their younger counterparts but still attained similar performance levels. When Bäckman and Nilsson (1996) covaried for education, 55 and 60 year olds outperformed both younger and older cohorts.

Although the preceding studies have indicated equivalent or superior performance of older adults on vocabulary measures at least up to the later decades of life, a more rigorous examination of these findings reveals a slightly different pattern of results. Botwinick and Storandt (1974) analyzed the quality of responses given by older and younger adults on the vocabulary subtest of the WAIS. Despite equivalency in accuracy scores across age groups, the definitions provided by older adults were judged to be qualitatively inferior to those provided by younger adults. Older adults were more likely to give multi-word responses and illustrations, rather than synonyms, for a given word. Older adults have also demonstrated poorer performance on "reverse" vocabulary tests which require the generation of a word in response to a given definition and a first-letter (Bowles & Poon, 1985). Older adults were slower and made more errors. Traditional vocabulary tests, therefore, may not be sufficiently sensitive to detect small age-related losses in semantic memory performance (Burke & Light, 1981).

Another factor that is important when examining performance on vocabulary tests and other measures requiring verbal skill is the gender of participants. A number of studies have indicated a female advantage on tasks which assess verbal skill (see Hyde & Linn, 1988; Maccoby & Jacklin, 1974, for reviews). Very little research, however, has been conducted examining potential gender differences in memory performance of older adults (Herlitz, Nilsson, & Bäckman, 1997). Schaie and Willis (1993) observed that women performed better that men on the easier of two vocabulary measures while men outperformed women on the more difficult version. Herlitz et al. (1997) did not find any gender differences on their vocabulary measure.

Fact Recall

Tests of fact recall measure an individual's knowledge about the world (e.g., geography, history, sports, science, and literature). This is knowledge that is acquired over the life span from both educational and day-to-day experiences (Camp, 1989). Overall, research examining age differences in fact recall performance generally indicates that either there are no differences between older and younger adults or that middle-aged and older adults outperform younger adults (Botwinick & Storandt,1980; McIntyre & Craik, 1987; Perlmutter, 1978; Small, Hultsch, & Masson, 1995). Botwinick and Storandt (1980), for example, examined fact recall performance of adults aged 20 to 79. They found that adults between 50 and 70 years performed at higher levels than any other age group although adults above 70 years performed at the lowest levels. Thus, studies that have examined fact recall performance of very old adults appear to be an exception to generally positive age differences. Bäckman and Nilsson (1996) found that adults aged 65 to 80 years recalled fewer facts than younger and middle-aged adults (aged 35 to 60 years). Statistically controlling for the effects of education did not affect these results.

One area of consideration when examining age differences on fact recall is the possibility that findings may be more cohort-related than age-related (Hultsch et al., 1998). Different age groups or cohorts may have been differentially exposed to items on the test. Therefore, findings of both age-related differences and similarities in performance are difficult to interpret. Just as dated information may favour older adults, more recent information may favour younger adults. Studies that have attempted to correct for cohort differences have not found age differences in fact recall performance

(Hultsch et al., 1998).

Gender differences have been examined in relation to fact recall performance. Botwinick and Storandt (1974) found that women performed very poorly on tests requiring the recall of socio-historical facts. Assuming that women were not acquiring the information to begin with, they concluded that tests employing socio-historical questions were not a good basis for assessing the memory of women. In 1980, they tested this assertion by examining fact recall performance on entertainment questions only. Neither gender nor age by gender interactions were observed. Herlitz et al. (1997) also failed to find any gender differences on their general knowledge test. Hultsch and colleagues (Hultsch, Masson, & Small, 1991; Small et al., 1995), on the other hand, found gender differences favouring men; however, it is not certain whether these differences can be accounted for by the presence of socio-historical questions on their fact recall measure.

Verbal Fluency Tasks

Verbal fluency tasks measure the number of words that can be written or spoken in a given time with certain features (e.g., beginning with a given letter, synonym, or antonym). These tasks assess an individual's ability to access multiple words through association indicating consolidation of encoded information in semantic memory (Horn & Hofer, 1992). Studies of age differences have yielded conflicting results. In some studies (e.g., Davis et al., 1990), age differences have been found to be slight or non-existent. However, similar to vocabulary performance, cross-sectional evidence from the SLS (Schaie, 1994; Schaie & Willis, 1993) indicated superior performance of young adults. Verbal fluency peaked in young adulthood and then showed linearly accelerated age differences. Evidence from Burke and Light (1981) and Salthouse (1993) supported this finding. Bäckman and Nilsson (1996), however, found that adults performed at equivalent levels from 35 up to age 50. Performance thereafter decreased linearly across age groups up to 80 years of age. When education was partialled out, 50 and 55 year olds outperformed younger adults and no age-related deterioration was observed until the age of 75. Longitudinal evidence from the SLS (Schaie, 1994) showed at least modest gain from young adulthood to early middle age, and significant decline by age 53. Schaie and Willis (1993) examined gender differences on the PMA word fluency test and observed that women performed better than men.

Semantic Verification

This task requires the participant to determine as quickly as possible whether or not a given sentence made logical sense. A highly salient feature of this task is the speed component. It is well-established that slowing of behaviour occurs with increasing age (Cerella, 1989; Salthouse, 1996). One would expect, therefore, that older adults would perform more poorly on this task compared to younger adults. Evidence from Hultsch, Hertzog, Small, McDonald-Miszczak, & Dixon (1992), examining longitudinal performance over a 3-year period, supports this expectation. Overall, Old-Old adults aged 71 to 86 performed at lower levels than Young-Old adults aged 55 to 70. Moreover, performance of Old-Old adults declined slightly across the 3-year period whereas Young-Old adults displayed gains in performance.

Lexical Decision

This task requires the participant to determine as quickly as possible whether a letter string composes an meaningful English word. Most often, this task has been examined within the context of a semantic priming paradigm whereby response time to a target word preceded by either a related or unrelated prime word is measured (Laver & Burke, 1993). In these cases, a neutral condition (i.e., XXXXX as the prime) can serve as the measure of lexical speed. Bowles & Poon (1985) found no differences between old and young adults in both accuracy and speed of performance on this task. Kausler (1994), on the other hand, reviewed evidence that older adults were slower overall in their lexical decisions than younger adults. Among a group of older adults, Hultsch et al. (1992) also observed negative age-related differences in performance. Old-Old adults were slower overall than Young-Old adults. Additionally, over a 3-year period, Young-Old adults exhibited gains in performance while Old-Old adults' performance declined.

Summary

The preceding literature review indicated an overall pattern of small differences in semantic memory performance from young to late adulthood. However, the pattern of results reported in this literature is inconsistent. Numerous studies have demonstrated equivalent performance of adults into the 60s or 70s. On some tasks, equivalence has been demonstrated into the 80s. On the other hand, some research has indicated that older adults perform at lower levels than younger adults, particularly on variants of standard vocabulary measures and on verbal fluency measures. It was suggested that differences in observed patterns were due to the complexity of the tasks examined or to the presence of much older participants in the sample (Bäckman & Nilsson, 1996). Little is known about semantic memory change in adulthood. In particular, the literature on semantic memory change in late adulthood is notably sparse.

A number of issues relating to the research on semantic memory should be noted. First, the majority of research examining age differences in semantic memory has been cross-sectional. One of the problems with age differences observed in cross-sectional studies is a confound due to cohort effects. According to Schaie (1994), cross-sectional studies will overestimate age-related decline prior to the 60s for those variables that show negative cohort gradients. Conversely, this decline will be underestimated for variables with positive cohort gradients.

Second, a limiting factor of much of this research has been the use of extreme-groups comparisons, typically contrasting young university students with a single group of older adults. Interpretation difficulties arise when either group is not representative of the general population. For example, an above-average subset of older adults will bias comparisons in favour of the older group (Miller, 1998).

Finally, despite the overall age-related pattern of mean level semantic memory performance, large individual differences exist. Individual differences have long been a concern for several reasons. Many participant-related factors including demographic (e.g., education, gender), lifestyle (e.g., social activity, exercise), biological (e.g., Vitamin B12, folic acid), neuropsychological (e.g., AD, normal aging), and cognitive (e.g., speed, working memory) can interact with aging serving to enhance or reduce age-related differences in memory performance (Bäckman et al., 2000; Nebes, 1989; West, Crook, & Barron, 1992). In particular, education has been shown to be positively related to cognitive performance (Albert et al., 1995; Bäckman et al., 2000; Birren & Morrison, 1961; Miller, 1998). This positive influence may be due to a number of factors including higher verbal ability, better use of mnemonic strategies, increased familiarity with test-taking, or greater exposure to content domain among those with more education (West et al., 1992). The research relating to gender issues is much less developed. Few studies have focussed on gender differences in the memory performance of older adults. Some evidence does exist, however, demonstrating a small advantage for women over men on list recall, text recall (Small et al., 1999; Zelinski, Gilewski, & Schaie, 1993) and other measures of episodic memory (Herlitz et al., 1997). Social, hormonal, and neurophysiological factors have been proposed as conceivable reasons to account for these patterns of gender differences in cognitive functioning (Bäckman et al., 2000).

Purpose of the Study

The general purpose of this study was to better understand semantic memory performance of older adults. Seven markers of semantic memory (i.e., vocabulary, fact recall, three verbal fluency measures, semantic verification, and lexical decision) were used. Long-term change in performance was examined with a small sample of older adults tested on five occasions over 13 years. In order to relate to the previous literature, cross-sectional baseline performance of the older sample was compared to a group of young adults. In addition, the contribution of participant-related factors (education and gender) to semantic memory performance were investigated. All of the data were collected in the context of the Victoria Longitudinal Study (VLS).

It was expected that observed longitudinal patterns would vary by the semantic task being examined. More specifically, it was hypothesized that tasks requiring simple retrieval of previously stored information from memory (e.g., recognition vocabulary) would exhibit little age-related change. Some change, however, would be observed in recall tasks which involve more complex retrieval processes (e.g., verbal fluency), and especially for such tasks requiring speeded performance (e.g., semantic and lexical decision).

Three general questions guide the present study: First, a preliminary question asks what the cross-sectional patterns of semantic memory performance in older adults will look like compared to young adults. Second, of paramount concern is the question: will age-related changes in semantic memory performance of older adults be observed? Third, will patterns of either differences (cross-sectional data) or changes (longitudinal data) be influenced by gender or years of education?

CHAPTER 3

Method

This chapter describes the sample of the current study and outlines the measures and the testing procedures used.

Participants

Participants in this study were part of a larger ongoing study of adult development, the Victoria Longitudinal Study (VLS). The original sample comprised 484 older adults ranging in age from 54 to 86 years (M = 69.19; SD = 5.87) at baseline testing. Beginning in 1986, participants have been tested at intervals of three years for a total of five waves of testing. An additional sample of 100 younger adult participants (recruited from the University of Victoria) were included at baseline testing only. These younger adults ranged in age from 19 to 36 (M = 24.77; SD = 4.69). The older participants were recruited from the community through public media advertisements and appeals to community groups. Compared to the general population, these older participants are a relatively select group. Eighty-one percent of the participants completed at least 11 years of education (M = 13.42 years; SD = 3.09). In contrast, only half (51%) of the population of British Columbia had attained similar levels (Statistics Canada, 1989). Furthermore, a large proportion of the sample (88%) rated their health as good or very good compared to others of the same age. Additional details about sample characteristics are described elsewhere (Dixon, Wahlin, Maitland, Hultsch, Hertzog, & Bäckman, 2000; Hultsch et al.,1998).

In the present study, both cross-sectional and longitudinal patterns of performance were examined. In both types of analyses, the older participants comprised only those participants (N = 124) who completed all five waves of testing. At baseline, these participants ranged in age from 54 to 82 years (M = 65.80, SD = 5.06). Their education level was similar to the total sample (M = 14.25; SD = 3.22).

The sample of older participants was divided into two age groups: Young-Old and Old-Old. The initial age of 67 was used as the cutoff for inclusion in the Young-Old age group. Thus, at baseline, the Young-Old were 54 to 67 and the Old-Old were 68 to 82 years of age. These divisions kept the range of ages for the two groups approximately equal (i.e., a span of 13 and 14 years respectively for each of the age groups) and were consistent with the Old-Old age group becoming the Very Old age group by Wave 5 (ranging in age from 81 to 95). Summary of the sample characteristics, including Young adults, are presented in Table 1.

Table 1
Sample Characteristics at Wave 1

	N	Mean Age	Age Range	Mean Educ.	Educ. Range
			Young		
Women	54	24.67 (5.15)	19-35	14.20 (2.05)	7-19
Men	46	24.89 (4.13)	20-36	15.37 (2.13)	8-21
Total	100	24.77 (4.69)	19-36	14.74 (2.16)	7-21
			Young-Old		
Women	50	62.80 (2.83)	56-67	14.00 (2.96)	9-21
Men	31	63.03 (3.03)	54-67	14.81 (3.10)	9-22
Total	81	62.89 (2.89)	54-67	14.31 (3.02)	9-22
			Old-Old		
Women	26	71.31 (3.65)	68-81	14.50 (3.48)	8-23
Men	17	71.24 (3.27)	68-82	13.59 (3.84)	8-22
Total	43	71.28 (3.47)	68-82	14.14 (3.61)	8-23
			Overall (Young-Old and Old-Old)		
Women	76	65.71 (5.12)	56-81	14.17 (3.13)	8-23
Men	48	65.94 (5.02)	54-82	14.38 (3.39)	8-22
Total	124	65.80 (5.06)	54-82	14.25 (3.22)	8-23

Note. Numbers represent values for participants who completed all five waves of testing. Numbers in parentheses represent standard deviations. Ranges are in years.

Measures

Semantic memory was assessed by seven different cognitive tests: vocabulary, fact recall, three verbal fluency measures, semantic verification, and lexical decision.

Vocabulary

The 54-item vocabulary measure was a compilation of three 18-item multiple-choice vocabulary tests from the ETS Kit of Factor-Referenced Cognitive Tests (Ekstrom, French, Harman, & Dermen, 1976) designed to measure knowledge of word meanings. Participants were given 15 minutes to complete the survey. The number of correctly answered items on each of the three 18-item tests constituted the vocabulary measure.

Fact Recall

The fact recall test is a measure of general world knowledge. Six sets of 40 questions, representing information from the domains of history, geography, science, art, and sports, were used (Nelson & Narens, 1980). Each participant received two sets administered in separate sessions (i.e., one set in session 1 and one set in session 2) for each wave. A participant would not receive the same set twice until the fourth wave of testing, approximately 10 years later. A sample item is: What is the longest river in South America? The number of correctly recalled facts averaged across the two sets constituted the measure of semantic memory.

Verbal Fluency

Performance on three tasks (from Ekstrom et al., 1976) constituted the verbal fluency measures. These tasks are Opposites, Similarities, and Figures of Speech. For the Opposites task, participants wrote up to six words that had an opposite, or near opposite, meaning to each word in a set of target words (i.e., calm, wrong, fair, and awkward). For the Similarities task, participants wrote as many words as possible that had the same or similar meaning to each word in a set of target words (i.e., clear, dark, strong, and wild). The Figures of Speech task required participants to write up to three words or phrases that could be used to complete each given figure of speech (e.g., the smell of fresh bread was like:). Each task was time-limited (5 minutes, 6 minutes, and 5 minutes, respectively). The number of acceptable responses was computed for each measure.

Semantic Verification

This is a measure of semantic decision speed adapted from procedures used by Palmer, MacLeod, Hunt, and Davidson (1985). In this task, participants were required to make rapid, but accurate, judgements about a set of sentences (e.g., The boy swam through a concrete wall.) as to whether they make sense or not. Stimuli were presented at the centre of a computer screen one at a time. Participants responded by pressing one of two buttons ("Y" for "Yes, the sentence makes sense" or "N" for "No, the sentence does not make sense"). Response time per item was recorded in milliseconds. The mean latency of correct responses was used as the measure. Values were reverse-coded to correspond with the direction of effect represented in the other measures (i.e., higher values = better performance). Values equal to or greater than three standard deviation units from the individual's mean were deleted.

Lexical Decision

This is a measure of lexical decision speed (Baddeley, Logie, Nimmo-Smith, & Brereton, 1985). In this task, participants decided whether strings of five to seven letters made up a real English word (e.g., cities) or made up a nonsense word (e.g., trian). Sixty letter strings were presented at the centre of a computer screen one at a time. Two presentation lists were used: one half of the participants were presented with list A and the other half of participants were presented with list B. Participants responded by pressing one of two buttons ("Y" for "Yes, the letters make up a real word" or "N" for "No, the letters do not make up a real word"). Response time per item was recorded in milliseconds. The mean latency of correct responses was used as the measure. Values were reverse-coded to correspond with the direction of effect represented in the other measures (i.e., higher values = better performance). Values equal to or greater than three standard deviation units from the individual's mean were deleted.

Procedure

All tasks for each wave were administered over four sessions spanning a period of approximately one month. Participants received the vocabulary, fact recall, and verbal fluency measures in a group setting during sessions 1 and 2 of the test battery. Semantic verification and lexical decision were administered individually by a tester in a separate room on a computer during session 3.

CHAPTER 4

Results

Overview

The data analysis consisted of two parts beginning with an examination of the cross-sectional patterns of semantic memory performance at baseline (1986). Both groups of older adults as well as a comparison sample of young adults were used. Next, longitudinal patterns of semantic memory performance of older adults were investigated. This first involved assessing the degree to which participants who completed all five waves of testing were representative of the original sample. An examination of mean level changes in semantic memory performance over the five waves (13 years) was then conducted.

Both cross-sectional and longitudinal analyses involved an additional examination of the influence of education on the pattern of results. All analyses were computed using alpha = .05.

Cross-Sectional Analyses

Inter-Task Correlations by Age Group

One of the purposes of the present research is to describe and explain age-related patterns in performance on different semantic memory tasks. The degree of inter-relatedness between semantic memory tasks was examined separately for each age group. The inter-task correlations are presented in Table 2. As expected, performance on different semantic memory tasks was significantly related. The two tasks most highly correlated with each other were the verbal speed measures of semantic verification and lexical decision (r's = .76, .72, and .55 for Young, Young-Old, and Old-Old age groups, respectively). These tasks, however, were frequently the least correlated with the other tasks in the study. Correlations with the other tasks did not exceed .48 in any age group and most were represented in the mid-teen to mid-20 range. Vocabulary was highly correlated with fact recall (r's = .66, .49, and .74 for Young, Young-Old, and Old-Old age groups, respectively) and with similarities (r's = .31, .54, and .51 for Young, Young-Old, and Old-Old age groups, respectively). As well, all of the verbal fluency measures were correlated. The magnitude of these relations was highest for the relation between opposites and similarities (r's = .60, .67, and .60 for Young, Young-Old, and Old-Old age groups, respectively) and lowest for the relation between opposites and figures of speech (r's = .29, .45, and .38 for Young, Young-Old, and Old-Old age groups, respectively).

When examining the relations among the tasks across age groups, a pattern emerged. For Young adults, inter-task correlations ranged from r = .14 to .76. On the basis of the lack of relatedness of the verbal speed measures to the other tasks, semantic verification and lexical decision were excluded from examination. This reduced the range of magnitude of correlation slightly, r = .14 to .66. Seven of the remaining correlations fell into the range of r = .20 to .35. For Young-Old adults, inter-task correlations ranged from r = .05 to .72. Removing semantic verification and lexical decision from the examination reduced the range to r = .24 to .67. Six out of the remaining ten correlations fell between r = .40 and .54. For Old-Old adults, inter-task correlations ranged from r = .11 to .74. Again, removing semantic verification and lexical decision tasks reduced the range slightly, r = .26 to .74. Six out of the remaining ten correlations fell between r = .45

and .60. It appears that when the range in magnitude of correlations across age groups is examined without the verbal speed measures, the magnitude of correlations increases with age.

Table 2
Correlations Between Performance on Semantic Memory Tasks by Age Group

	1	2	3	4	5	6	7	8
			Young					
1. Age	----							
2. Vocabulary	.28*	----						
3. Fact Recall	.26*	.66*	----					
4. Opposites	-.26*	.31*	.29*	----				
5. Similarities	-.15	.31*	.35*	.60*	----			
6. Figures of Speech	-.01	.14	.20*	.29*	.30*	----		
7. Semantic Verification	-.24*	.48*	.28*	.30*	.26*	.16	----	
8. Lexical Decision	-.20*	.33*	.24*	.28*	.24*	.16	.76*	----
			Young-Old					
1. Age	----							
2. Vocabulary	.00	----						
3. Fact Recall	.05	.49*	----					
4. Opposites	.14	.49*	.36*	----				
5. Similarities	.28*	.54*	.33*	.67*	----			
6. Figures of Speech	.16	.40*	.24*	.45*	.54*	----		
7. Semantic Verification	-.08	.26*	.24*	.26*	.12	.13	----	
8. Lexical Decision	-.21	.15	.31*	.17	-.05	.13	.72*	----
			Old-Old					
1. Age	----							
2. Vocabulary	.00	----						
3. Fact Recall	-.15	.74*	----					
4. Opposites	.00	.47*	.45*	----				
5. Similarities	-.17	.51*	.34*	.60*	----			
6. Figures of Speech	-.13	.46*	.26	.38*	.51*	----		
7. Semantic Verification	-.16	.28	.27	.26	.16	.15	----	
8. Lexical Decision	-.37*	.17	.35*	.33*	.22	.11	.55*	----

* $p < .05$.

Age Differences

Cross-sectional analyses were conducted on data from the first wave of collection to examine the degree of comparability with previous results reported in the literature. A young adult comparison group was also included. A 2 (gender) by 3 (age group: Young, Young-Old, and Old-Old) multivariate analysis of variance (MANOVA) was conducted. Raw scores for each variable were converted to standardized T-scores. The overall test revealed significant main effects for both age group, Wilks' $\Lambda = .43$, $F\ (14, 420) = 15.84$, $p < .001$, $\eta^2 = .35$ (see Figure 1), and gender, Wilks' $\Lambda = .80$, $F\ (7, 210) = 7.52$, $p < .001$, $\eta^2 = .20$. No age group by gender interaction was observed. Except for two of the verbal fluency measures (opposites and similarities), univariate tests for age group showed significant differences on all of the tasks: vocabulary, $F\ (2, 216) = 73.96$, $p < .001$, $\eta^2 = .41$, fact recall, $F\ (2, 216) = 18.39$, $p < .001$, $\eta^2 = .41$, figures of speech, $F\ (2, 216) = 3.21$, $p = .042$, $\eta^2 = .03$, semantic verification, $F\ (2, 216) = 5.61$, $p = .004$, $\eta^2 = .05$, and lexical decision, $F\ (2, 216) = 14.06$, $p < .001$, $\eta^2 = .12$. In each case, pair-wise comparisons revealed that the effect for age was due to differences between Young adults and both Young-Old and Old-Old adults. The performance of the two groups of older adults did not significantly differ from each other on any task. Effect sizes (Cohen's d[1]) for tasks in which significant age group effects were observed are presented in Table 3. The direction of the effect differed according to the task examined. In the case of vocabulary and fact

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[1] d was calculated as the difference between two raw score means (e.g., between Young and Young-Old) divided by the pooled standard deviation of the two groups on which the means were based.

recall, older adults (Young-Old adults – vocabulary: M = 55.36, SD = 6.65; fact recall: M = 53.24, SD = 7.84, and Old-Old adults – vocabulary: M = 56.51, SD = 7.17; fact recall: M = 52.87, SD = 8.95) performed at higher levels than Young adults (vocabulary: M = 42.86, SD = 8.62; fact recall: M = 46.14, SD = 10.70). The direction of the effect was reversed for figures of speech, semantic verification, and lexical decision. Young adults (figures of speech: M = 51.81, SD = 9.24; semantic verification: M = 52.34, SD = 10.24; lexical decision: M = 53.70, SD = 9.63) outperformed both Young-Old (figures of speech: M = 49.00, SD = 10.24; semantic verification: M = 48.43, SD = 9.52; lexical decision: M = 47.29, SD = 10.05) and Old-Old adults (figures of speech: M = 47.66, SD = 10.69; semantic verification: M = 47.53, SD = 9.34; lexical decision: M = 46.49, SD = 7.77). Although the univariate test for age group on the opposites task was not significant, pair-wise comparisons revealed that Young adults (M = 51.44, SD = 10.03) performed at a significantly higher level than Old-Old adults (M = 47.53, SD = 9.52). Univariate tests for gender showed significant differences for the fact recall task only, F (1, 216) = 32.01, $p < .001$, $\eta^2 = .13$. Men (M = 54.86, SD = 8.98) outperformed women (M = 47.78, SD = 9.71) on this task. This represented a large effect (i.e., Cohen's d = .75 SD).

Table 3

Effect Sizes for Significant Age Differences Between Young Adults and Young-Old and Old-Old Adults

	Cohen's d	
Task	Young and Young-Old	Young and Old-Old
Vocabulary	-1.60	-1.66
Fact Recall	-.74	-.66
Figures of Speech	.29	.43
Semantic Verification	.39	.48
Lexical Decision	.65	.79

Note. Negative numbers indicate poorer performance of Young adults.

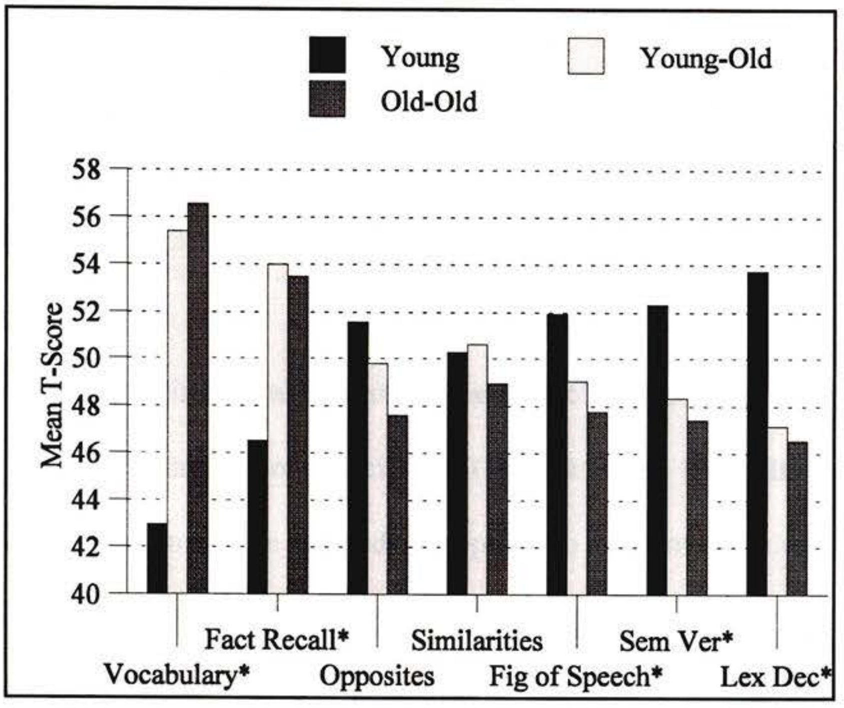


Figure 1. Mean level (standardized score) performance on semantic memory tasks as a function of age group.

Covarying Education

Prior research has indicated that education level correlates with memory ability (Kausler, 1994; Nilsson et al., 1997). A 2 (gender) by 3 (age group: Young, Young-Old, and Old-Old) multivariate analysis of covariance (MANCOVA), with years of education as the covariate, was conducted on all of the semantic memory tasks. The overall test revealed a significant main effect for the covariate education, Wilks' $\Lambda = .79$, $F\ (7, 209) = 7.88$, $p < .001$, $\eta^2 = .21$, and again revealed significant main effects for both age group, Wilks' $\Lambda = .44$, $F\ (14, 418) = 15.37$, $p < .001$, $\eta^2 = .34$, and gender, Wilks' $\Lambda = .80$, $F\ (7, 209) = 7.49$, $p < .001$, $\eta^2 = .20$. The pattern of significant univariate tests indicated that accounting for education removed the effect for age group for the third verbal fluency measure (figures of speech) as well as for the semantic verification task. Again, univariate tests for gender showed significant differences for the fact recall task only, $F\ (1, 215) = 31.86$, $p < .001$, $\eta^2 = .13$.

Longitudinal Analyses

Selective Attrition

Change observed in longitudinal studies is often obscured by the effects of attrition (i.e., systematic dropout of participants) (Horn & Hofer, 1992). It is often the case that persons who return to be retested are superior in terms of both demographic characteristics and baseline cognitive functioning than those who fail to return which may affect the external validity of results (Bäckman et al., 2000; Hultsch et al., 1998; Siegler & Botwinick, 1979; Zelinski et al., 1993). Specifically, an underestimation of age-related decline for the age range studied may occur (Taylor, Miller, & Tinklenberg, 1992;

Bäckman et al., 2000).

An attrition analysis was conducted to determine whether participants who completed all five waves of testing were representative of the original sample with respect to demographic characteristics (age, education, and self-reported health) and semantic memory performance. Baseline performance of Wave 5 returnees was compared to baseline performance of all those from the original sample who did not return for retest at Wave 5.

The initial educational and health characteristics of all the participants who did and did not return for all five waves of testing are summarized in Table 4. A 2 (age group) by 2 (gender) by 2 (return status) MANOVA was conducted to determine whether age, education, or self-reported health differences between returnees and dropouts existed. There were significant differences between returnees and dropouts in age, $\underline{F}$ (1, 453) = 5.78, $\underline{p}$ = .017, η^2 = .01, and in self-reported health, $\underline{F}$ (1, 453) = 6.39, $\underline{p}$ = .012, η^2 = .01. Specifically, those who remained in the study were slightly younger and reported better health in relation to age-mates than those who failed to return. Participants who stayed in the study were not significantly better educated than those who dropped out. There was also a significant interaction between gender and return status, $\underline{F}$ (1, 453) = 4.71, $\underline{p}$ = .03, η^2 = .01. Whereas women who remained in the study had more education, on average, than women who dropped out, men who remained had less education, on average, than men who dropped out.

Table 4
Background Characteristics of Returning and Nonreturning Participants

	Young-Old				Old-Old			
	Returnees		Dropouts		Returnees		Dropouts	
Variable	Women	Men	Women	Men	Women	Men	Women	Men
N	50	31	74	44	26	17	137	105
Age								
M	62.80	63.03	63.45	63.98	71.31	71.24	73.66	72.73
SD	2.83	3.03	2.43	2.26	3.65	3.27	4.41	3.92
Education								
M	13.62	14.24	13.03	14.31	13.38	12.00	13.01	13.85
SD	3.00	2.95	3.00	3.35	2.60	3.53	2.64	3.58
Self-Rated Health								
M	1.50	1.45	1.70	1.66	1.38	1.56	1.64	1.72
SD	.59	.78	.77	.68	.62	.70	.71	.71

Note. For self-rated health, participants were asked to rate their health as compared to age-mates on a 5-point scale (1 = very good, 5 = very poor).

To examine whether selective attrition effects were present for the semantic memory variables, a 2 (age group) by 2 (gender) by 2 (return status) MANOVA on baseline performance was conducted. Raw scores were converted to standardized T-scores. Means and standard deviations for each task are shown in Table 5. The overall test revealed significant effects for both age group and gender. More importantly, a significant effect for return status was observed, Wilks' Λ = .94, F (7, 458) = 4.10, $p < .001$, η^2 = .06. No interactions with return status were significant.

For the univariate tests of return status, baseline performance of returnees was significantly higher than that of dropouts on 5 out of 7 tasks. Significant differences were found for vocabulary, F (1, 464) = 11.31, p = .001, η^2 = .02, fact recall, F (1, 464) =

27.33, $p < .001$, $\eta^2 = .06$, opposites, $F(1, 464) = 6.16$, $p = .013$, $\eta^2 = .01$, semantic verification, $F(1, 464) = 7.89$, $p = .005$, $\eta^2 = .02$, and lexical decision, $F(1, 464) = 6.68$, $p = .01$, $\eta^2 = .01$. In each case, mean level of performance of returnees was significantly higher than that of dropouts. The biggest difference in mean level performance between returnees and dropouts occurred on the fact recall task (mean difference standardized T-score units between returnees and dropouts: Young-Old = 4.21; Old-Old = 6.43). Although there was no significant interaction between return status and age group, a trend was apparent. In all cases, differences in mean level performance between returnees and dropouts were larger in the Old-Old age group. This essentially replicates results reported by Hultsch et al. (1992; 1998) which examined attrition effects after three years. However, the present analyses also indicated differences on return status for lexical decision. As well, only one verbal fluency measure, opposites, was significant. Hultsch et al. (1992; 1998) used a composite measure of all three verbal fluency measures. A significant effect for return status was found for this composite verbal fluency. This effect may have been driven by performance on the opposites task. Overall, the existence of a positive selective attrition effect as indicated by the present analyses has implications for the interpretation of the following longitudinal examination of age changes in semantic memory performance. It is likely that the following results will be an underestimate of age-related change in the general population of older adults.

Table 5

Means (M) and Standard Deviations (SD) in Standardized T-Scores of All Semantic Memory Variables: Selective Attrition Analysis

Variable	Young-Old Returnees	Young-Old Dropouts	Old-Old Returnees	Old-Old Dropouts
Vocabulary[a]				
M	52.00	48.76	53.73	49.23
SD	7.41	9.45	7.59	10.92
Fact Recall[a]				
M	54.00	49.79	54.26	47.83
SD	7.75	9.66	8.56	10.37
Opposites[a]				
M	52.84	50.99	51.59	48.28
SD	8.98	9.79	8.40	10.21
Similarities				
M	51.47	50.82	52.28	48.70
SD	9.29	9.64	9.49	10.19
Figures of Speech				
M	51.29	51.13	50.84	48.80
SD	8.52	10.00	8.92	10.36
Semantic Verification[a]				
M	53.31	51.59	52.31	47.51
SD	8.72	9.23	7.82	10.66
Lexical Decision[a]				
M	52.74	50.69	52.15	48.32
SD	9.30	10.37	6.93	10.34

[a] significant effect for return status.

Longitudinal Change

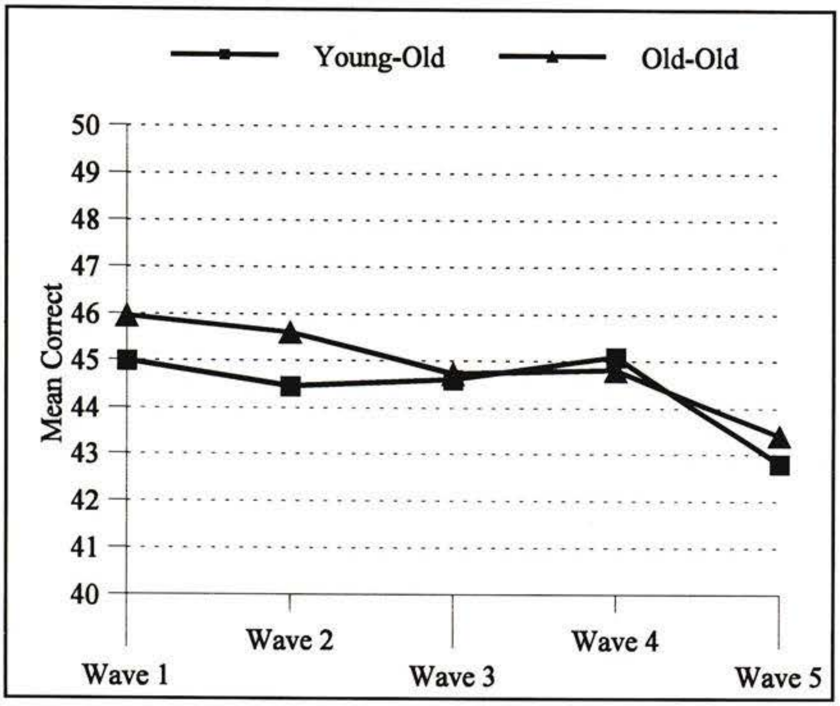
In order to address the issue of age-related changes in semantic memory performance of older adults over the five waves of testing, a 2 (age group) by 2 (gender) by 5 (wave) repeated-measure multivariate analysis of variance (R-MANOVA) on all semantic memory measures was conducted. The univariate repeated-measure analysis of variance (R-ANOVA) test results were then examined for each task.

Overall R-MANOVA results. The overall tests revealed significant effects for age group, Wilks' $\Lambda = .83$, $F\ (7, 114) = 3.24$, $p = .004$, $\eta^2 = .17$, and gender, Wilks' $\Lambda = .76$, $F\ (7, 114) = 5.19$, $p = .000$, $\eta^2 = .24$, but no age group by gender interaction. Additionally, a significant effect for wave, Wilks' $\Lambda = .26$, $F\ (28, 93) = 9.29$, $p = .000$, $\eta^2 = .74$, and a significant wave by age group interaction, Wilks' $\Lambda = .61$, $F\ (28, 93) = 2.12$, $p = .004$, $\eta^2 = .39$, was observed. Neither the wave by gender nor the wave by age group by gender interactions were significant.

Univariate R-ANOVA results. Appendix A shows the means and standard deviations of raw scores for each of the semantic memory measures for each of the five waves of testing. Appendix B shows the simultaneous presentation of figures for each of the semantic memory tasks using standardized T-score form. Analyses were essentially the same as on the raw scores. For reasons of interpretation, raw scores are presented here. Appendix C presents effect sizes (Cohen's d) for age group differences at each of the five waves for each of the tasks.

Vocabulary. A significant effect for wave, $F\ (4, 480) = 20.08$, $MSE = 102.32$, $p < .001$, $\eta^2 = .14$, was observed. Specifically, performance declined from Wave

1 to Wave 5. Given the 5-wave nature of the data, linear, quadratic, cubic, and order 4 trends were examined. All were significant: $\underline{F}_{Linear}$ (1, 120) = 50.33, <u>MSE</u> = 249.42, $\underline{p} <$ .001, $\eta^2 = .30$; $\underline{F}_{Quadratic}$ (1, 120) = 8.36, <u>MSE</u> = 35.87, $\underline{p} = .005$, $\eta^2 = .07$; $\underline{F}_{Cubic}$ (1, 120) = 11.59, <u>MSE</u> = 52.4, $\underline{p} = .001$, $\eta^2 = .09$; and $\underline{F}_{Order4}$ (1, 120) = 4.37, <u>MSE</u> = 17.01, $\underline{p} = .04$, $\eta^2 = .04$. Differences in average performance from Wave 1 to Wave 4 only amounted to .52 correct responses. Decline was greater from Wave 4 to Wave 5 (difference in average performance = 1.85 correct responses). No significant effects for age group, gender, or any interaction were observed (see Figure 2).



<u>Figure 2.</u> Vocabulary task performance across wave as a function of age group.

Fact Recall. A significant effect for gender was observed, $F(1, 120) = 12.24$, $MSE = 1387.31$, $p = .001$, $\eta^2 = .09$. Men ($M = 22.43$, $SD = 4.99$) performed at higher levels overall than women ($M = 19.21$, $SD = 5.46$). No gender interactions were observed. Overall, performance changed with repeated waves of testing as evidenced in the main effect for wave, $F(4, 480) = 22.63$, $MSE = 199.92$, $p < .001$, $\eta^2 = .16$. Specifically, performance declined from Wave 1 to Wave 5. Both linear and quadratic trends were observed, $F_{Linear}(1, 120) = 73.23$, $MSE = 585.04$, $p < .001$, $\eta^2 = .38$, and $F_{Quadratic}(1, 120) = 6.97$, $MSE = 32.46$, $p < .01$, $\eta^2 = .06$. Decline was greatest from Wave 4 to Wave 5. Although no main effect for age group was observed, there was a significant interaction between wave and age group, $F(4, 480) = 4.31$, $MSE = 38.11$, $p < .01$, $\eta^2 = .04$ (see Figure 3). Old-Old adults' performance deteriorated across the five waves to a greater degree than performance of Young-Old adults. Young-Old adults declined on average by 2.15 correct responses from Wave 1 to Wave 5; Old-Old adults declined by 3.92 correct responses in the same time frame.

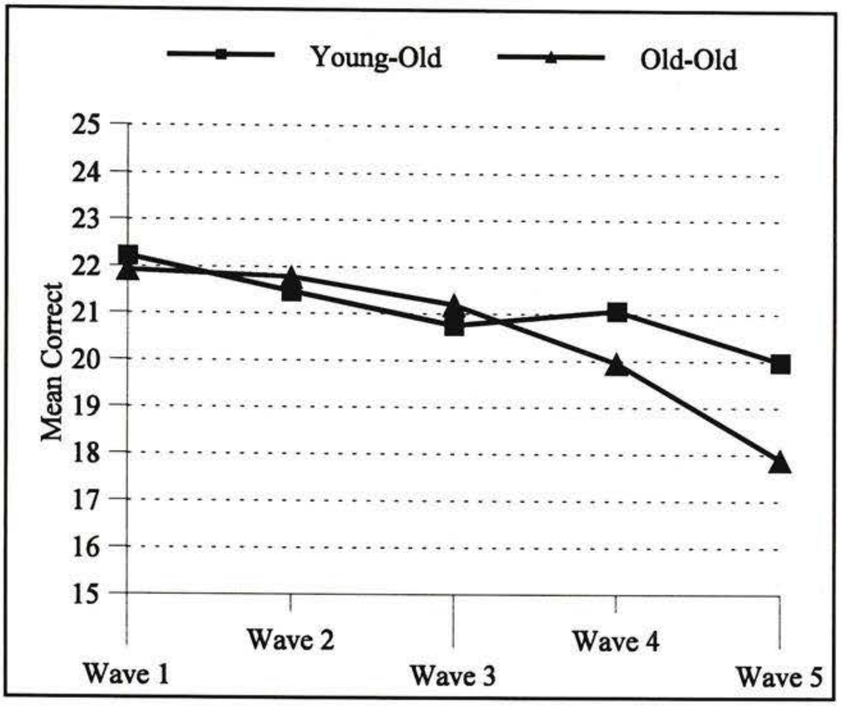


Figure 3. Fact Recall task performance across wave as a function of age group.

Opposites. A main effect for age group, $\underline{F}$ (1, 120) = 7.47, $\underline{MSE}$ = 441.80, $\underline{p}$ = .007, η^2 = .06, was observed. Young-Old adults ($\underline{M}$ = 12.96, $\underline{SD}$ = 3.54) were able to generate more antonyms overall than Old-Old adults ($\underline{M}$ = 11.14, $\underline{SD}$ = 3.51). A significant main effect for wave, $\underline{F}$ (4, 480) = 9.45, $\underline{MSE}$ = 69.20, $\underline{p}$ < .001, η^2 = .07, was observed. Specifically, performance declined from Wave 1 to Wave 5. Linear, quadratic, and cubic trends were observed, $\underline{F}_{Linear}$ (1, 120) = 16.23, $\underline{MSE}$ = 129.20, $\underline{p}$ < .001, η^2 = .12, $\underline{F}_{Quadratic}$ (1, 120) = 8.12, $\underline{MSE}$ = 53.62, $\underline{p}$ < .01, η^2 = .06, $\underline{F}_{Cubic}$ (1, 120) = 11.95, $\underline{MSE}$ = 71.09, $\underline{p}$ < .001, η^2 = .09. Decline was greatest from Wave 4 to Wave 5. The longitudinal patterns by age group are plotted in Figure 4. No significant effects for gender or any interaction were apparent.

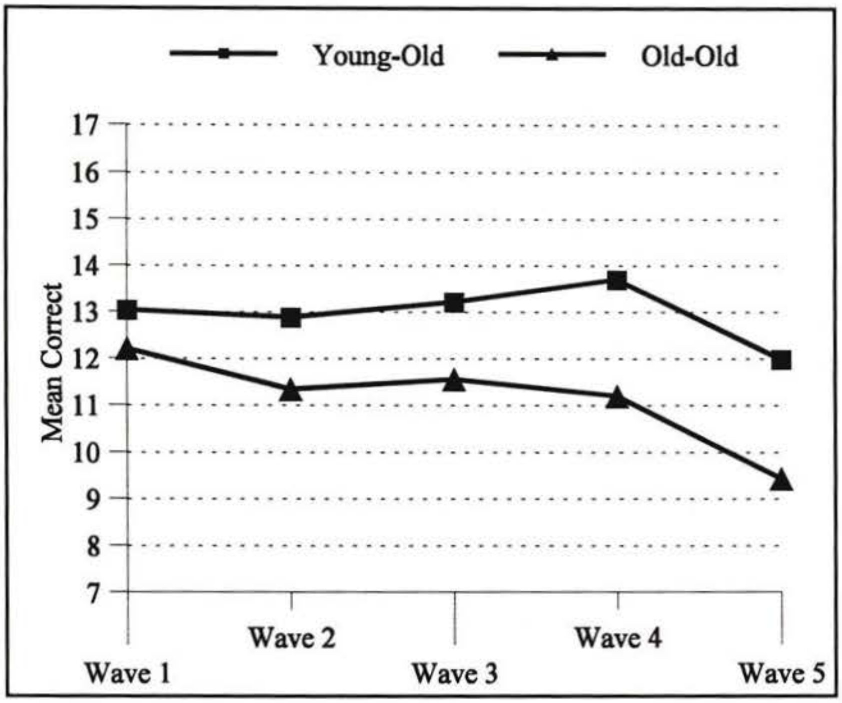


Figure 4. Opposites task performance across wave as a function of age group.

Similarities. A significant main effect for age group, F (1, 120) = 4.92, MSE = 618.70, p = .028, η^2 = .04, was observed. Young-Old adults (M = 14.37, SD = 5.16) were able to generate more synonyms overall than Old-Old adults (M = 12.22, SD = 5.13). A significant main effect for wave, F (4, 480) = 13.74, MSE = 141.83, $p < .001$, η^2 = .10, was observed. Overall, performance declined from Wave 1 to Wave 5. Linear and quadratic trends were observed, F_{Linear} (1, 120) = 24.34, MSE = 221.48, $p < .001$, η^2 = .17, $F_{Quadratic}$ (1, 120) = 22.47, MSE = 230.73, $p < .001$, η^2 = .16. Performance was relatively stable up to Wave 4; however, significant decline had occurred by Wave 5. The longitudinal patterns by age group are plotted in Figure 5. No significant effects were found for gender nor any interaction.

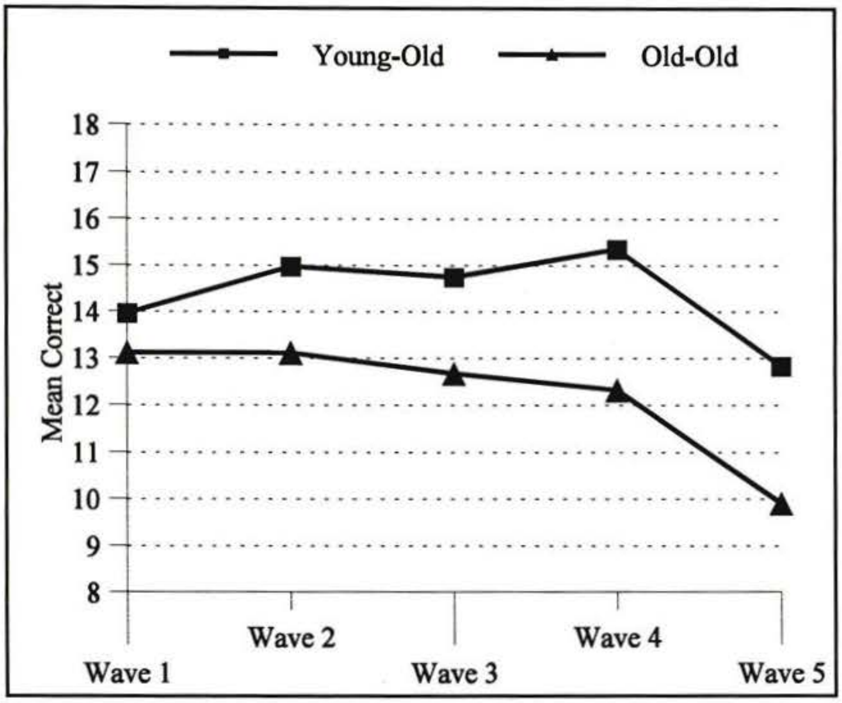


Figure 5. Similarities task performance across wave as a function of age group.

Figures of Speech. A main effect for age group, F (1, 120) = 8.72, MSE = 228.05, p = .004, η^2 = .07, was observed. On average, Young-Old adults (M = 10.41, SD = 2.35) generated more figures of speech completions than Old-Old adults (M = 9.10, SD = 2.34) on this task. A significant main effect for wave, F (4, 480) = 9.91, MSE = 34.41, p < .001, η^2 = .08, was observed. In general, performance declined from Wave 1 to Wave 5. Linear and cubic trends were observed, F_{Linear} (1, 120) = 19.12, MSE = 77.92, p < .001, η^2 = .14, F_{Cubic} (1, 120) = 15.86, MSE = 46.59, p < .001, η^2 = .12. An interaction between wave and age group was observed, F (4, 480) = 4.65, MSE = 16.14, p = .001, η^2 = .04 (see Figure 6). The difference in average performance from Wave 1 to Wave 5 for Old-Old adults was 2.21 appropriate responses. Young-Old adults, on the other hand, did not change their relative performance from Wave 1 to Wave 5 (i.e., difference in average performance from Wave 1 to Wave 5 = .61 appropriate responses). No gender differences were observed.

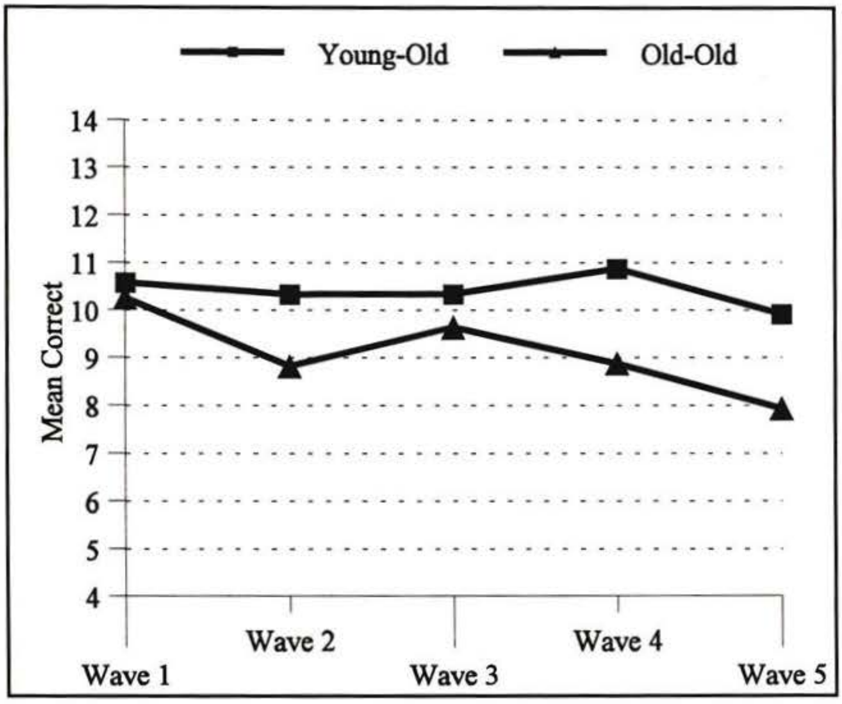


Figure 6. Figures of Speech task performance across wave as a function of age group.

Semantic Verification. A main effect for age group, F (1, 120) = 4.43, MSE = 13517240.91, p = .037, η^2 = .04, was observed. Young-Old adults (M = 3412.88, SD = 803.77) performed at faster levels overall than Old-Old adults (M = 3094.96, SD = 799.04). A significant main effect for wave, F (4, 480) = 9.43, MSE = 2270954.57, p < .001, η^2 = .07, was observed. This was primarily due to a significant drop in performance at Wave 2. Linear and cubic trends were observed, $\underline{F}_{Linear}$ (1, 120) = 19.12, $\underline{MSE}$ = 77.92, $\underline{p} < .001$, $\eta^2 = .14$, $\underline{F}_{Cubic}$ (1, 120) = 15.86, $\underline{MSE}$ = 46.59, $\underline{p} < .001$, $\eta^2 = .12$. An interaction between wave and age group was observed, $\underline{F}$ (4, 480) = 4.40, $\underline{MSE}$ = 1059313.09, $\underline{p}$ = .003, $\eta^2 = .04$ (see Figure 7). The average performance of Old-Old adults decreased by 146.81 ms from Wave 1 to Wave 5. Young-Old adults, on the other hand, improved their performance from Wave 1 to Wave 5 (i.e., difference in average performance from Wave 1 to Wave 5 = 307.21 ms). No gender differences were apparent.

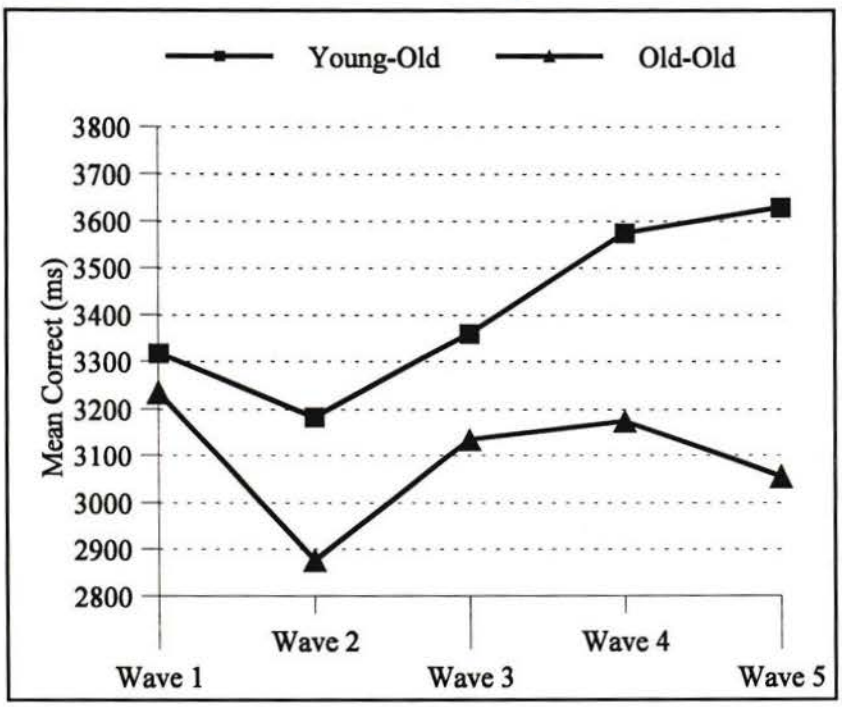


Figure 7. Semantic Verification task performance (reverse-coded) across wave as a function of age group.

Lexical Decision. A main effect for age group, $F(1, 120) = 4.03$, $MSE = 964144.06$, $p = .047$, $\eta^2 = .03$, was observed. Young-Old adults ($M = 1086.75$, $SD = 225.09$) performed at faster levels overall than Old-Old adults ($M = 1001.85$, $SD = 223.76$). A significant main effect for wave, $F(4, 480) = 5.47$, $MSE = 159471.75$, $p < .001$, $\eta^2 = .04$, was observed. Pairwise comparisons revealed that this effect was due to significantly slower performance at Wave 2. Linear and cubic trends were observed, $F_{Linear}(1, 120) = 19.12$, $MSE = 77.92$, $p < .001$, $\eta^2 = .14$, $F_{Cubic}(1, 120) = 15.86$, $MSE = 46.59$, $p < .001$, $\eta^2 = .12$. An interaction between wave and age group was observed, $F(4, 480) = 2.90$, $MSE = 84405.22$, $p = .026$, $\eta^2 = .02$ (see Figure 8). Whereas the difference in average performance from Wave 1 to Wave 5 for Young-Old adults was an increase of 93.28 ms, for Old-Old adults this value did not change (17.43 ms). No gender differences were apparent.

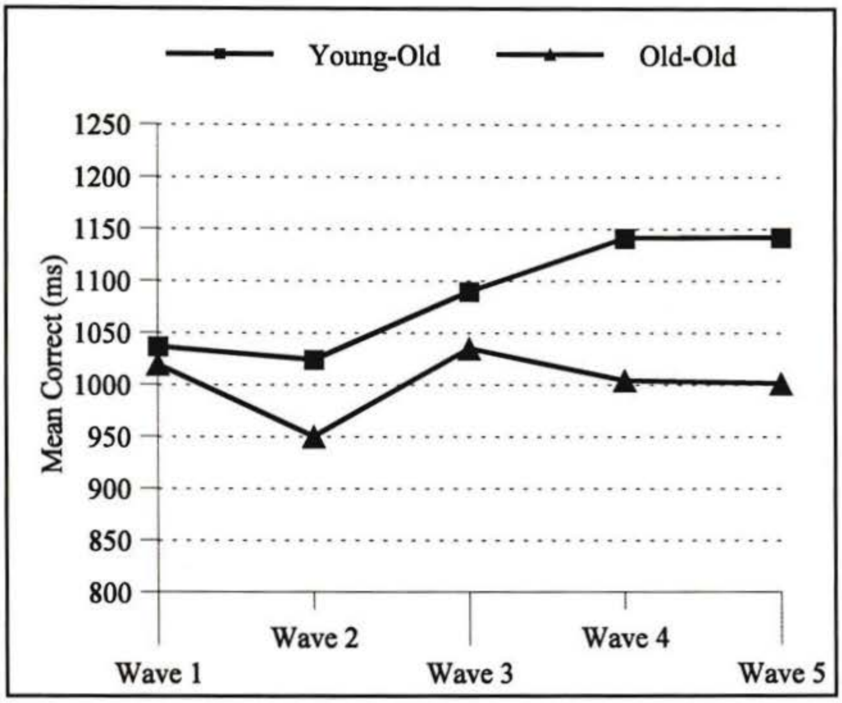


Figure 8. Lexical Decision task performance (reverse-coded) across wave as a function of age group.

Covarying Education

A 2 (age group) by 2 (gender) by 5 (wave) repeated-measure multivariate analysis of covariance (R-MANCOVA) was performed on all semantic memory measures. Adjustment was made for the effects of education on performance.

Overall R-MANCOVA results. The overall test revealed a significant main effect for the covariate education, Wilks' $\Lambda = .76$, F (7, 113) = 5.16, $p < .001$, $\eta^2 = .24$. However, the adjustment for education did not affect the overall multivariate pattern of results observed in the R-MANOVA. Significant main effects for age group, Wilks' $\Lambda = .84$, F (7, 113) = 3.16, $p = .004$, $\eta^2 = .16$, and gender, Wilks' $\Lambda = .76$, F (7, 113) = 5.16, p

= .000, $\eta^2 = .24$, were observed, but no age group by gender interaction. Additionally, there was a significant effect for wave, Wilks' $\Lambda = .65$, $\underline{F}$ (28, 92) = 1.76, $\underline{p} = .024$, $\eta^2 = .35$, and a significant wave by age group interaction, Wilks' $\Lambda = .61$, $\underline{F}$ (28, 92) = 2.10, $\underline{p} = .005$, $\eta^2 = .39$. Both the wave by gender and the wave by age group by gender interactions were not significant.

Univariate R-ANCOVA results. Adjusting for educational differences did not change the pattern of main effects for age. However, the main effect of wave disappeared for all but the fact recall task, $\underline{F}$ (4, 476) = 6.48, $\underline{MSE}$ = 56.03, $\underline{p} < .001$, $\eta^2 = .05$. The pattern of significant wave by age group interactions across tasks (previously significant for fact recall, figures of speech, semantic verification, and lexical decision) was not affected by the adjustment for educational level, fact recall, $\underline{F}$ (4, 476) = 4.25, $\underline{MSE}$ = 36.78, $\underline{p} = .005$, $\eta^2 = .04$; figures of speech, $\underline{F}$ (4, 476) = 4.70, $\underline{MSE}$ = 16.39, $\underline{p} = .001$, $\eta^2 = .04$; semantic verification, $\underline{F}$ (4, 476) = 4.34, $\underline{MSE}$ = 1041556.24, $\underline{p} = .003$, $\eta^2 = .04$; and lexical decision, $\underline{F}$ (4, 476) = 2.88, $\underline{MSE}$ = 83793.28, $\underline{p} = .03$, $\eta^2 = .02$.

CHAPTER 5

Discussion

The purpose of the present study was to examine longitudinal patterns of performance on seven semantic memory tasks for a group of older adults, initially ranging in age from 54 to 82 years. The bulk of the literature to date has been cross-sectional and has used extreme-group comparisons. The specific goals of this study were: (a) to examine cross-sectional performance of Young, Young-Old, and Old-Old adults, (b) examine longitudinal performance of Young-Old and Old-Old adults, (c) compare longitudinal patterns with those observed in cross-sectional research, and (d) ascertain the influence of education and gender on semantic memory performance.

Cross-Sectional Results

Age-group comparisons on all tasks failed to demonstrate differences between Young-Old and Old-Old adults. Cross-sectional analyses, therefore, were ultimately reduced to a simple extreme-group comparison between performance of Young adults to two older groups (Young-Old and Old-Old adults). Age-group differences were found on all of the semantic memory tasks except for opposites and similarities. Whether these differences favoured younger or older adults depended on the task being examined. Whereas age group differences on vocabulary and fact recall favoured older adults, differences were in favour of younger adults on figures of speech, semantic verification, and lexical decision. These effects are illustrated in Figure 1. Note that although age group differences for opposites and similarities were non-significant, differences tended to favour younger adults.

Longitudinal Results

The longitudinal results were more complex. Hence, discussion of these results will be handled in a task by task fashion.

Vocabulary

The previous literature has indicated slightly variable patterns in vocabulary performance: either no age differences from young to late adulthood (Berkowitz, 1953), increases in performance up to midlife and linear decreases thereafter (Bäckman & Nilsson, 1996; SLS - cross-sectional: Schaie, 1994), or increases in performance up to midlife and stability thereafter until very old age (Giambra et al., 1995; Gilinsky & Judd, 1994; SLS - longitudinal: Schaie, 1994). The present results could be consistent with the last pattern. Although there were no significant age group differences, or a significant wave by age group interaction, there was a significant effect for wave. Performance declined from Wave 1 to Wave 5. An examination of mean levels of performance indicated that this decline did not begin until Wave 5 for Young-Old adults when the age of these participants ranged from 67 to 80. The age range of Old-Old adults was slightly higher (74 to 88 years) when decline first became apparent (i.e., Wave 3). Thus, the longitudinal pattern of vocabulary performance appears to indicate stability into the 70s. The pattern of cross-sectional results at Wave 1 was not inconsistent with these findings. Although Young-Old and Old-Old adults performed at similar levels, both age groups outperformed a group of Young adults. Overall, the pattern of results indicates stability across the adult years until very old age.

Fact Recall

The literature on the fact recall task has generally indicated one of two things: either that no age differences exist or that older adults perform better than younger adults. Cross-sectional results indicating no age group differences between Young-Old and Old-Old adults were in line with these findings. Although no significant age group differences were found in the longitudinal examination, a significant wave by age group interaction was present. Consistent with previous reports of 3-wave data for a similar sample (Hultsch et al., 1998), both older age groups declined in performance by the third wave of testing. The interesting effect occurred, however, when the next two waves were examined. By Wave 4, the degree of decline had accelerated in the Old-Old age group (aged 78 to 92) compared to Young-Old adults (aged 64 to 77) (see Figure 3). If one were able to follow the present sample across further waves of testing, it is plausible that the gap between the two groups would increase further leading to a significant age group effect in favour of Young-Old adults. Contrary to both the literature and cross-sectional results, longitudinal findings indicated a pattern of accelerated decline with increasing age in late adulthood.

Verbal Fluency Tasks

The literature on verbal fluency tasks has painted an inconsistent picture. That is, either age group differences were slight or non-existent (e.g., Davis et al., 1990), stability was indicated until midlife with linear decline thereafter (e.g., Bäckman & Nilsson, 1996), or decline was evident from early adulthood onwards (e.g., Schaie & Willis, 1993). Overall, age group differences for the five wave data were apparent on all of the verbal fluency measures in the present study. Young-Old adults outperformed Old-Old adults on each measure. An examination of mean levels of performance indicated a non-significant trend on the opposites task showing that differences between age groups modestly increased across waves. Whereas Young-Old adults did not begin to decline until Wave 5 (between the ages of 67 and 80), Old-Old adults exhibited decrements as early as Wave 2 (between the ages of 71 to 85). Both of these patterns converged to suggest a picture of decline beginning close to the age of 70. In contrast to the present longitudinal findings of age group differences between Young-Old and Old-Old adults, cross-sectional results indicated no differences in performance between these two groups. Despite this, the additional cross-sectional finding of no differences between young and older adult age groups combined with the pattern of age ranges of the two groups when decline became apparent suggests that opposites task performance exhibits stability until the late 60s and early 70s. This stands in contrast to the bulk of the literature in which age differences become apparent before the early 50s (Bäckman & Nilsson, 1996; Burke & Light, 1981; Salthouse, 1993; Schaie, 1994). These results are also inconsistent with cross-sectional results at Wave 1 which showed no age group differences between Young-Old and Old-Old adults. An identical picture of results was portrayed for both similarities and figures of speech. However, for figures of speech, the wave by age group interaction achieved significance.

Semantic Verification

The longitudinal analyses indicated overall age group differences favouring Young-Old adults. A significant wave by age group interaction was also indicated. An examination of mean performance levels indicated that no real decline occurred in the

Young-Old group across all five waves. In fact, Young-Old adults demonstrated modest gains in performance overall (see Figure 7). Old-Old adults, on the other hand, began to decline by Wave 2 when these participants ranged in age from 71 to 85. These results support findings by Hultsch et al. (1992). Young-Old adults had stable or slightly increasing performance across two waves of data collection, whereas Old-Old adults exhibited a slight decline. Once again, cross-sectional results indicating a lack of age group differences between Young-Old and Old-Old adults at Wave 1 were not consistent with the longitudinal picture.

<u>Lexical Decision</u>

The pattern of longitudinal results for this task differed somewhat from the pattern for semantic verification. Young-Old adults again displayed modest gains in performance across five waves; however, Old-Old adults maintained their performance across the five waves (see Figure 8). Hultsch et al. (1992) found decline in performance of Old-Old adults after 3 years (i.e., two waves). Old-Old adults from the more select sample in the present study also demonstrated a similar decline by Wave 2. By Wave 3, however, performance had risen to Wave 1 levels and this was maintained until Wave 5. The cross-sectional results at Wave 1 were not consistent with the picture of age group differences between Young-Old and Old-Old adults.

Methodological Issues

<u>Longitudinal Versus Cross-Sectional Findings</u>

When Wave 1 cross-sectional results were examined exclusively, no age group differences between Young-Old and Old-Old adults were found to exist on any task. One might conclude from this that very little "change" in semantic memory occurs as a result of the aging process and it is only in the case of extreme-groups that we are able to observe decline at all. An examination of longitudinal patterns, on the other hand, indicated that age-group differences existed between Young-Old and Old-Old on all tasks except vocabulary and fact recall. In all cases of significant differences, Young-Old adults outperformed Old-Old adults. In addition, wave by age group interactions were found on four of the measures: fact recall, figures of speech, semantic verification, and lexical decision with the remaining measures exhibiting marginal interaction effects. This was most often the result of more precipitous decline in the Old-Old age group. These data present a picture of accelerated decline with increasing age. The conclusion to be drawn here is that estimates of age-related changes in performance based on multiple time points are far more valuable than a single estimate derived from one point in time.

Additionally, cross-sectional analyses showed a dissociation in the age effect pattern that was not indicated by the longitudinal results. When Young adults were compared to the two older groups (Young-Old and Old-Old), age-group differences were found on all tasks except opposites and similarities. Performance on two of the tasks favoured older adults while performance on the remaining four tasks favoured younger adults. The tasks (vocabulary and fact recall) favouring older adults in the cross-sectional analyses, no longer displayed significant age effects in longitudinal analyses. What could account for these discrepant patterns in results? A closer examination of these results revealed that both groups of older adults displayed almost identical mean level Wave 1 performance for both the vocabulary and fact recall tasks. The age effect occurred as a result of the much poorer performance of Young adults who were not part of the longitudinal analysis.

Selective Attrition

According to Schaie and Willis (1993), both cross-sectional and longitudinal data have the ability to under- or over-estimate age-related decline. In cross-sectional research, those variables which ordinarily produce positive cohort trends can paint a bleak picture of the aging process. Conversely, a more hopeful picture is generated from variables which produce negative cohort trends. The above analyses presented patterns indicative of the latter type of estimation problems. In all cases, cross-sectional research indicated no differences between Young-Old and Old-Old, essentially creating a more positive picture of the aging process than is indicated by longitudinal results, On the other hand, estimates of age-relates change in longitudinal research can be minimized or exaggerated due to the effects of selective attrition.

The attrition analyses performed in the present study represent a conservative analysis as it compared 13-year returnees to a combined sample of three-, six-, and nine-year dropouts. Dropouts themselves have been shown to differ on key variables (e.g., occupation, health) based on which wave they failed to return for (Hultsch et al., 1992). Reasons for dropout change across waves with lack of motivation to be a more likely reason in earlier waves and mortality issues to increase as a reason in later waves. On the whole, attrition results from the present study indicated that the sample experienced selective attrition with respect to the ages and health of the participants as well as with respect to their overall semantic memory performance. Those who remained were younger, reported better health, and performed at a higher level than those who dropped out of the study. This, of course, limits the generalizability of the present findings. In this case, it is expected that the present findings were an under-representation of true age change. Had those who dropped out remained in the study, it is speculated that more change over time would have been observed.

Specific Task Issues

The differences observed in the direction of age-group effects found in cross-sectional results led to a number of questions: (a) What are the task-related factors that might account for these differential patterns of performance? (b) Are all of the tasks equally good indicators of semantic memory? and (c) Are these differences in patterns a reason to question the distinction between episodic and semantic memory which is partly derived from the observation of different age trajectories in mean level performance across the life span?

Although longitudinal findings did not support the finding of striking dissociations among semantic memory tasks, the question about the contribution of task-related factors to age-group differences remains an interesting one. In light of evidence indicating a slowing of responses with increasing age (Salthouse, 1994; Schaie & Willis, 1993), an obvious task-related factor to examine is the degree to which each task is speeded. In the present study, vocabulary[2] and fact recall are unspeeded measures.

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Although there is a time limit on the vocabulary measure, the minutes allotted are extremely generous (i.e., 15 minutes for 54 multiple-choice items). Thus, for comparative purposes, the vocabulary test was considered an untimed measure.

Opposites, similarities, and figures of speech, on the other hand, have a timed component. So too do semantic verification and lexical decision which require very fast responding. In general, the magnitude of age differences between young and old increases when speeded task are used. A comparison of the differences between tasks in the magnitude of age effects can be made by examining the standardized T-score graphs in Appendix B. Effect sizes for age differences at each wave for each task are presented in Appendix C. An examination of differences between slopes for Young-Old and Old-Old age groups illustrates that greater age differences are more apparent for speeded than for unspeeded tasks. Additionally, although not significant for opposites or similarities, these age group differences became larger at later waves of testing as evidenced in age group by wave interactions.

Another task-related factor involves how the task requires information to be retrieved from long-term memory. Tasks involving simple retrieval processes (i.e., recognition of correct response) are often easier than those requiring more complex retrieval such as those involved in recall tasks. Age differences are more likely to be observed on recall tasks. Was this true in the present study? Findings represented conflicting results in this regard. The seven markers of semantic memory could be classified either as recognition tasks: vocabulary, semantic verification, and lexical decision, or as recall tasks: fact recall, opposites, similarities, and figures of speech. Vocabulary was the only task out of the seven which failed to find either a significant effect for age group, age group by wave, or both. All of the recall tasks, on the other hand, exhibited at least one of these effects. However, both semantic memory and lexical decision also exhibited significant age group and age group by wave effects of a similar magnitude to the verbal fluency measures. The speed component of these tasks is likely to be the driving force of observed age differences on these tasks.

Additionally, one may question whether all of the semantic memory tasks are equally good indicators of semantic memory and whether all of them should be used as such. Not all indicators will measure an underlying construct with the same efficiency. Performance on some tasks will differ qualitatively and by the degree to which it is related to variance on other constructs that change across age (Schaie & Willis, 1993). Verbal speed measures such as semantic verification and lexical decision, for example, may be indicators of semantic memory ability but may also be indicators of perceptual speed which would confound age change and bias estimates of semantic memory ability for those adults who have been showing slowing of response. This points to the benefit of using multiple indicators of a construct (Hultsch et al., 1998; Schaie & Willis, 1993).

In the present study, inter-task correlations were computed to assess the degree of relatedness among indicators of semantic memory across age groups. It appears that the magnitude of correlations increased with increasing age at least when the verbal speed measures were not examined. One theory of aging postulates that the distinctions between different cognitive abilities will weaken and become more interdependent as people age. This "de-differentiation hypothesis" specifically predicts that correlations among abilities should increase in old age. According to Schaie (1996), most of the evidence goes against this notion. Other prominent aging researchers would disagree (e.g., Lindenberger and Baltes, 1997; Salthouse, 1996). Indeed, the present data appear to support the de-differentiation hypothesis. At the very least, the present data point to a need to examine the structure of semantic memory across age groups.

The last question arising from the differential cross-sectional patterns of performance questions the justifiability of distinguishing between episodic and semantic memory (Mitchell, 1989). Prior research has shown dissociations in the patterns of age-related trajectories for episodic and semantic memory (see Kausler, 1994, for a review). In general, age differences in episodic memory are larger and occur at earlier points in the life span than semantic memory. In the present study, cross-sectional results showed that within semantic memory the same type of dissociation can be observed. Some semantic memory tasks exhibited age differences similar in direction to those observed in episodic memory tasks. The longitudinal results, however, did not support these findings.

Individual Difference Variables

Finally, the issue of the influence of background characteristics of education and gender need to be addressed. In the present study, education had little impact on age differences in semantic memory performance. Despite the finding of a significant main effect for the covariate education, none of the longitudinal patterns of significant age group effects were altered. Although the univariate analyses revealed a disappearance of the wave effect for all but the fact recall task, wave by age group interactions were maintained. The cross-sectional analyses, however, indicated reduced age differences to non-significant levels for figures of speech and semantic verification. This was most likely due to slightly higher levels of education of Young adults. This did not equate to a reduction in the age effect for vocabulary, a task known to be highly correlated with education. Young adults demonstrated drastically inferior performance on this task.

Gender, as well, played little role in explaining individual differences in task performance. Evidence from both cross-sectional and longitudinal analyses converged to indicate gender differences on a single semantic memory task: fact recall. Men performed at higher levels than women. It is unlikely that this effect was the result of superior semantic memory ability of men given that the effect only showed up on a single task. Botwinick and Storandt (1974; 1980) believed that the socio-historical content of their test was the underlying cause of observed gender differences favouring men. They assumed that women were not learning this type of information and concluded that fact recall tasks including questions of this nature did not provide a fair assessment of women's memory. This assumption may be reasonable given that gender-based roles, especially in older cohorts, may have limited the opportunities of women by limiting their exposure (e.g., due to different interests or responsibilities) to certain types of information. Gender differences found in the present analyses suggest that this is not a cohort-specific effect. Differences were just as apparent in the Young adult group as they were in the two older populations; in fact, differences in this group were slightly though not significantly larger. When Botwinick and Storandt (1974; 1980) restricted questions to entertainment content, no gender differences were found. The fact recall task in the present study is composed of items from a broad range of categories including history. Failure at initial learning, therefore, remains one possible explanation for the present results.

Contributions and Implications of This Study

Present cross-sectional findings provide a link for comparative purposes to much of the literature on age differences in semantic memory. Interestingly, differences between Young-Old and Old-Old adults were not significant for any of the seven tasks at Wave 1. As these findings indicate, if measurement was confined to a single occasion, we would conclude that semantic memory does not change with age on the basis of these results. However, in the present case, such a conclusion would be misleading. The five wave longitudinal data, comprised of the same individuals used in the cross-sectional analyses, yielded a different pattern of results. Unlike the cross-sectional findings, the longitudinal results indicated a pattern of gradual decline over 13 years for each of the semantic memory tasks. This decline was observed despite analyses indicating the selectivity of the present sample with respect to age and health characteristics compared to the entire original sample at Wave 1. Moreover, this decline was accelerated for the Old-Old group for four of the measures. Tasks exhibiting these wave by age group interactions could, in part, be distinguished on the basis of a timed component. The same performance distinctions could not be made on the basis of differences in retrieval properties associated with tasks. An examination of the influence of education and gender on semantic memory performance showed that both exerted little influence on observed performance of the present sample.

Some memories are like old trees unbending in the blowing wind, standing tall and steadfast until strong gales gradually overcome them. JANINE HAZLITT

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Appendix A

Means (M) and Standard Deviations (SD) in Raw Scores of the Semantic Memory Measures for each of Five Waves of Testing

Task	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Overall
Vocabulary						
YO						
M	44.96	44.49	44.72	45.12	42.83	44.38
SD	5.60	5.51	5.13	4.92	5.73	5.68
OO						
M	45.93	45.70	44.81	44.93	43.56	44.90
SD	6.04	6.70	6.91	6.67	6.10	5.64
Overall						
M	45.47	45.03	44.66	44.95	43.10	44.64
SD	5.68	6.45	6.28	6.05	6.34	5.94
Fact Recall[a]						
YO						
M	21.77	21.18	20.42	20.69	19.62	21.10
SD	4.82	5.42	5.19	4.94	5.99	4.90
OO						
M	21.55	21.41	20.81	19.56	17.63	20.54
SD	5.50	5.64	6.68	5.73	5.81	4.87
Overall						
M	22.07	21.62	20.98	20.51	18.93	20.82
SD	5.12	5.77	6.01	5.37	6.26	5.12
Opposites[a]						
YO						
M	12.94	12.94	13.23	13.59	11.91	12.96
SD	3.76	3.99	4.51	4.53	4.32	3.54
OO						
M	12.19	11.42	11.63	11.28	9.53	11.14
SD	3.57	4.04	4.29	4.12	3.51	3.51
Overall						
M	12.62	12.11	12.38	12.44	10.71	12.05
SD	4.00	4.34	4.81	4.75	4.39	3.70

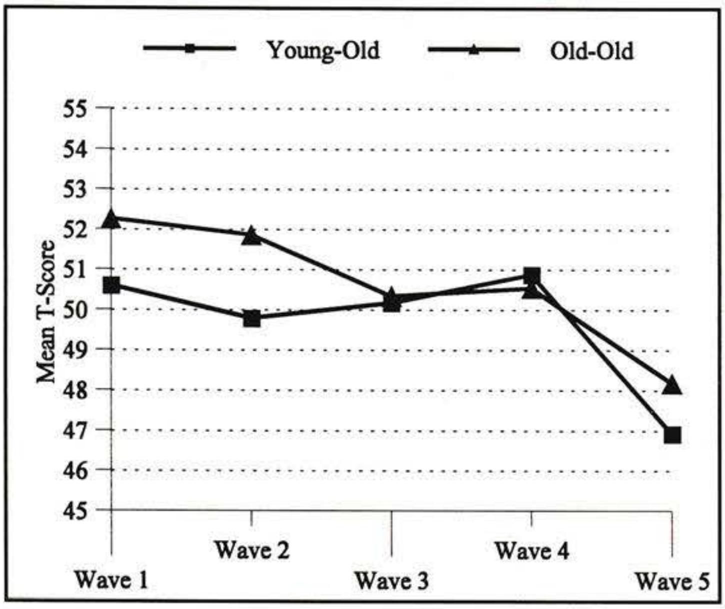
Similarities[a]						
YO						
M	13.74	14.73	14.70	15.17	12.62	14.37
SD	5.19	6.17	6.00	6.47	5.34	5.16
OO						
M	13.26	13.28	12.88	12.63	10.28	12.22
SD	4.94	5.20	6.33	5.66	5.47	5.13
Overall						
M	13.53	14.04	13.71	13.83	11.36	13.30
SD	5.47	6.27	6.60	6.64	5.68	5.40
Figures of Speech[a]						
YO						
M	10.57	10.30	10.27	10.90	9.96	10.41
SD	2.56	2.93	2.81	2.90	2.72	2.35
OO						
M	10.23	8.81	9.60	9.02	8.02	9.10
SD	2.67	2.67	3.02	2.81	2.81	2.34
Overall						
M	10.42	9.57	9.98	9.87	8.92	9.75
SD	2.82	3.08	3.12	3.07	3.02	2.46
Semantic Verification[b]						
YO						
M	3326.84	3182.46	3363.14	3575.97	3634.05	3412.88
SD	842.60	745.60	908.74	897.40	978.06	803.77
OO						
M	3182.46	2902.32	3172.94	3191.84	3101.03	3094.96
SD	826.30	804.37	899.47	915.00	938.94	799.04
Overall						
M	3299.44	3085.31	3297.18	3442.77	3449.21	3375.65
SD	834.47	774.87	906.44	918.35	994.03	841.16
Lexical Decision[b]						
YO						
M	1040.55	1024.42	1083.51	1140.03	1133.83	1086.75
SD	278.01	219.89	266.83	249.77	266.91	225.09
OO						
M	1018.52	953.39	1032.42	997.77	1001.09	1001.85
SD	215.00	214.22	260.12	373.62	253.46	223.76
Overall						
M	1032.91	999.79	1065.79	1090.70	1087.80	1066.50
SD	257.22	219.70	264.59	304.73	268.88	235.56

Note. YO = Young-Old; OO = Old-Old. Semantic verification and lexical decision tasks represent reverse-coded raw scores (higher scores = faster performance).
[a] Number correct or recalled. [b] Mean rate of response in ms.

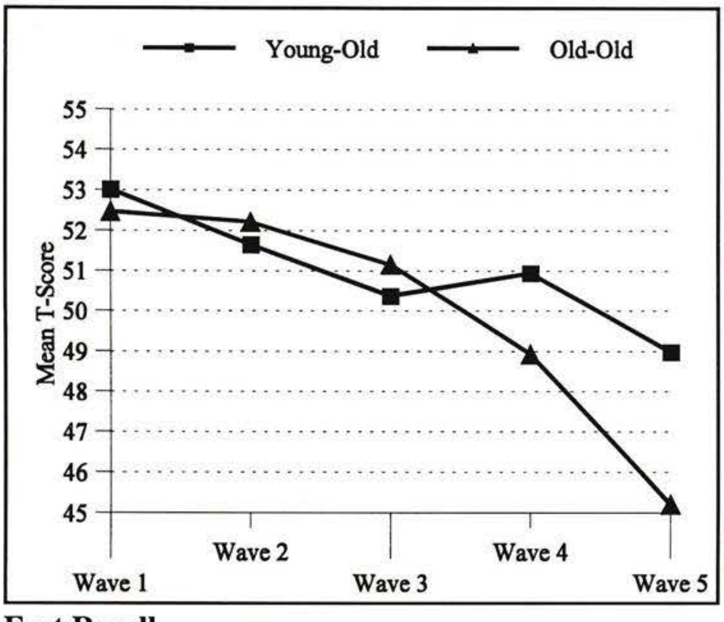
Appendix B

Mean Level (Standardized T-score) Performance Across Wave

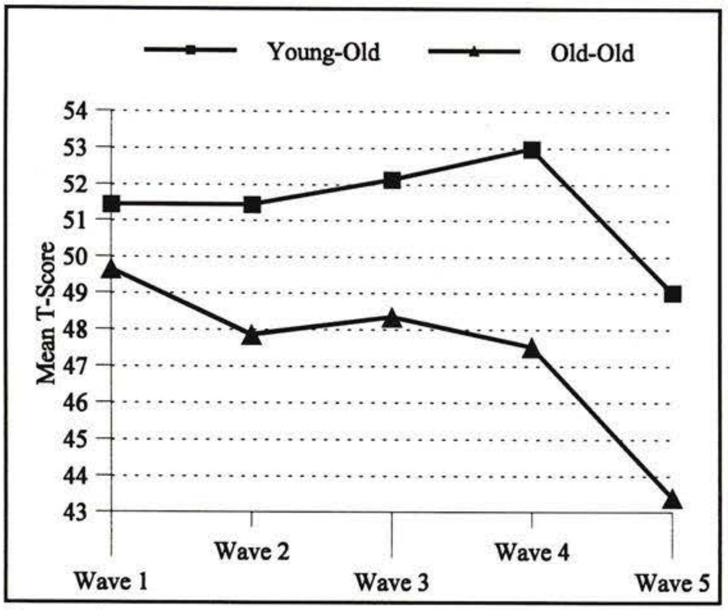
as a Function of Age Group



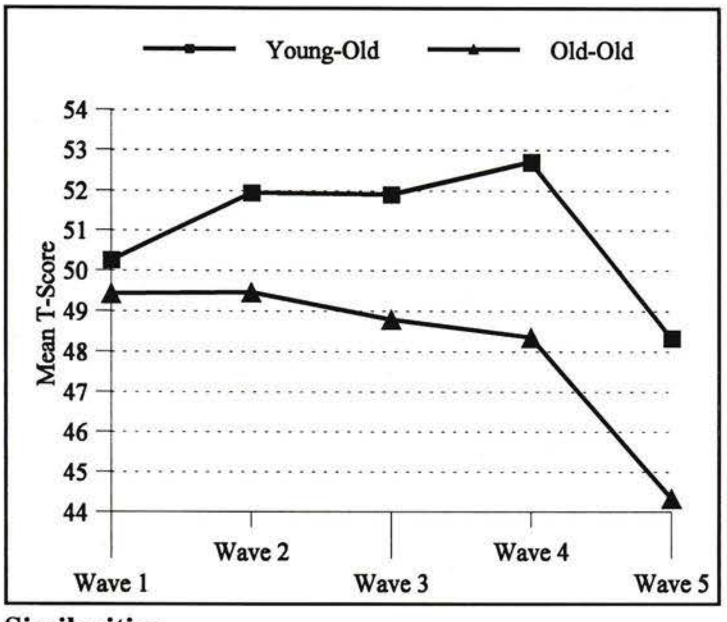
Vocabulary



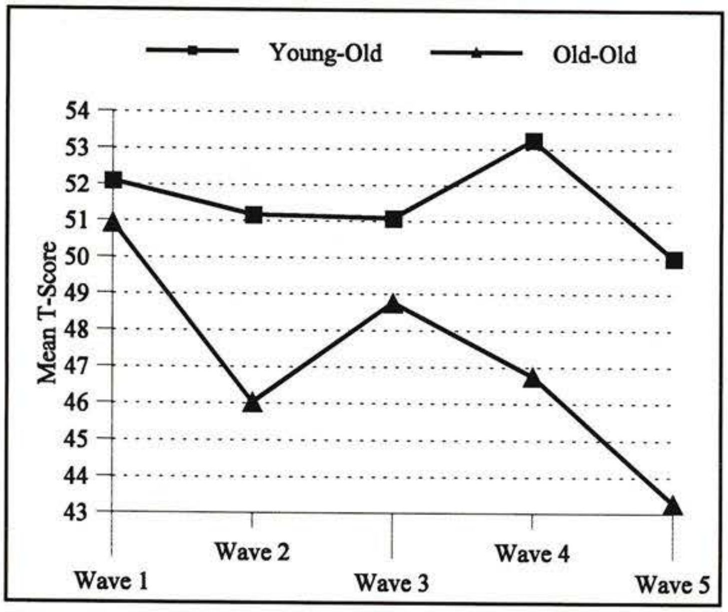
Fact Recall



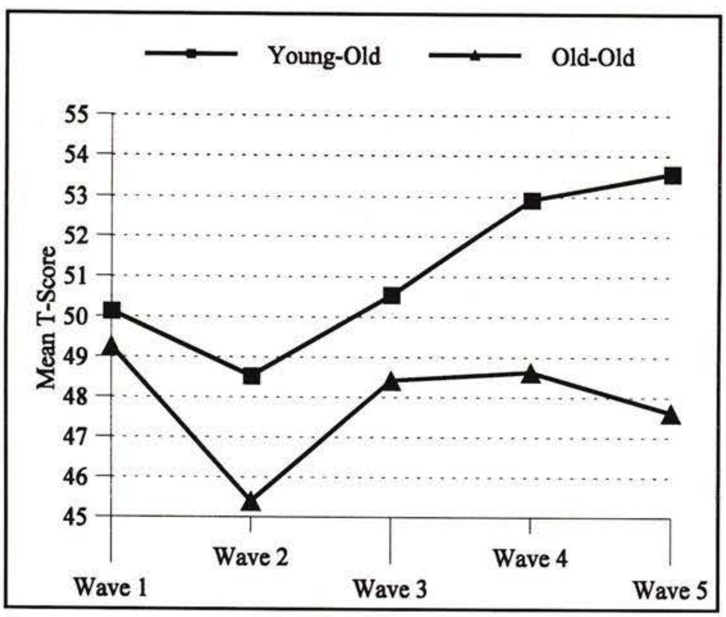
Opposites



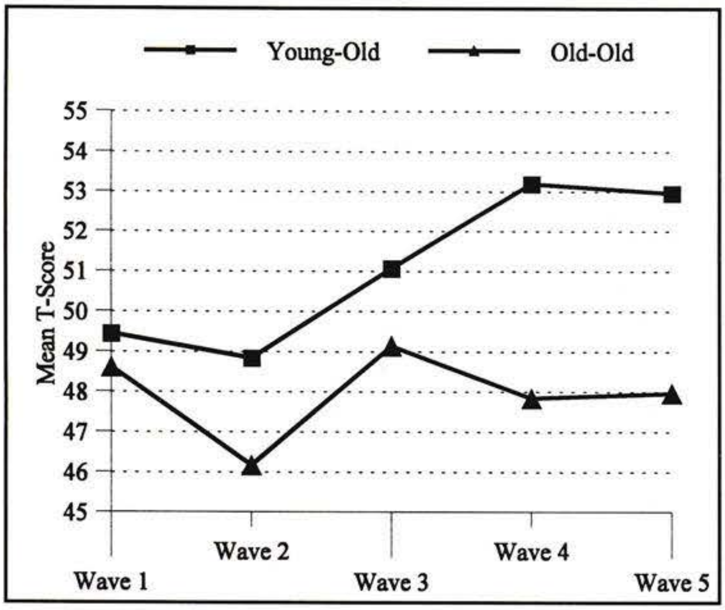
Similarities



Figures of Speech



Semantic Verification



Lexical Decision

Appendix C

Effect Sizes for Age Group Differences at Each of Five Waves

Task	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Vocabulary	-.17	-.20	-.02	.03	-.12
Fact Recall	.04	-.04	-.07	.22	.34
Opposites	.20	.38	.36	.53	.59
Similarities	.09	.25	.30	.41	.43
Figures of Speech	.13	.52	.23	.66	.71
Semantic Verification	.17	.37	.21	.43	.55
Lexical Decision	.09	.33	.19	.48	.51

Note. Numbers represent Cohen's d values computed using means for Young-Old and Old-Old age groups. Where negative numbers are indicated, Young-Old adults performed more poorly than Old-Old adults.

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Conference Presentations:

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Cohen, A-L., Hazlitt, J. E., Dixon, R. A., & Hultsch, D. F. (1998, April). Handwriting performance in older adults as an indicator of psychomotor speed. Paper presented at The Seventh Cognitive Aging Conference, Atlanta, GA.

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Toastmasters International	1999-