A Longitudinal Study of the Cognitive Performance of Healthy and Demented Very Old Adults

by

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ABSTRACT

This study was designed to increase the general understanding of the cognitive abilities of very old adults, and how these abilities relate to the use of compensatory memory strategies, awareness of memory functioning, and depressive affect. The initial sample included two groups of adults over the age of 77 years. One group included 95 participants diagnosed as healthy with a Mini-Mental Status Exam (MMSE) M = 28, SD = 2.15. The other group included 11 participants diagnosed as probable Alzheimer's disease (AD) with a MMSE M = 23, SD = 3.82. Participants were tested on five occasions at six-month intervals over a period of two years.

First, psychometric analyses indicated that measures of intelligence, compensation, and depression behave reliably in the two groups of very old adults. Second, these measures differentiate between those in the early stages of AD and healthy elderly individuals, with the latter showing higher levels of performance than the former across the five occasions.

Third, overall, participants with AD used fewer compensatory memory strategies, (such as memory aids) than did healthy adults. In addition, healthy adults used more external strategies (such as notes), while participants with AD reported that they relied increasingly more on others.

Fourth, there was a moderate relationship between intelligence and awareness of deficits. Participants with AD, who experienced greater levels of cognitive deficits, were less aware of their dysfunction than were nonimpaired, healthy participants.

Fifth, healthy participants and those with AD had similar levels of depression in the six months following diagnosis, but the depression level of healthy participants increased over the two years. As well, depression was related to observed indicators of awareness, and combined with diagnosis had a significant impact on the Performance subscale of the Wechsler Adult Intelligence Scale-Revised.

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Dedication

To Garry, April, and Kory for hanging in there. The ride was rough, but you never lost faith.

Chapter I

Introduction

A Longitudinal Study of the Cognitive Performance of Healthy and Demented Very Old Adults

The segment of the population over the age of 65 years is increasing at a dramatic rate, with the percentage of those over the age of 80 years showing the most growth (Denton, Feaver, & Spencer, 1987). As the population ages, scientific investigations into the developmental changes associated with age has attempted to keep pace. In recent years research attention has focused on the cognitive changes associated with the early stages of the aging process, but the investigation of cognitive development after the age of 75 years remains limited. While many elderly adults lead happy and productive lives to an advanced age, aging is all too often accompanied by an increased vulnerability to dementing illness, such as Alzheimer's disease. Separating the changes associated with normal aging from the pathological states further complicates research on aging.

In this study I investigated changes in the cognitive performance of very old healthy adults, over the age of 75 years, on tests of intelligence. The performance of this group will be compared to a second group of same aged adults, assessed over the same time period, who have been diagnosed with probable Alzheimer's disease (AD). It is hoped that an examination of the differences and

similarities in the cognitive performance of these two groups, and a comparison of the changes that occur in each group over a two year period will aid in the understanding of the cognitive abilities of very old healthy adults, as well as our understanding of the early stages of AD.

General age-related decline in many aspects of cognitive performance have been consistently observed, although many very old adults continue to show expert levels of ability with complex tasks, and carry out the tasks of daily living without difficulty (Hultsch & Dixon, 1990; Salthouse, 1987; Schaie, 1990). It has been proposed that strategies are developed to compensate for objective or perceived decrements (Dixon & Bäckman, in press; Salthouse, 1987). The present study also investigates the use of compensatory memory strategies by healthy and demented very old adults. The aim is to provide a description of the strategies used by these older people, as well as to examine the relationship between strategy use and intelligence.

Awareness of cognitive dysfunction, as is suggested by the use of compensation strategies is commonly associated with depression. Therefore, I examine factors in the complex relationship between intelligence, awareness, and depression in this sample.

The literature concerned with two areas of research related to cognitive aging will be reviewed in the second chapter. First, studies examining age-associated changes in

the cognitive abilities of very old healthy adults will be reviewed to provide a standard of normal development. In contrast, the second area of research will discuss the changes in general intelligence associated with AD. This will be followed by a review of the literature discussing memory compensation, deficit awareness and cognitive abilities. Finally, the research literature pertaining to depression in very old healthy and demented adults will be examined. The hypotheses of the study will be outlined following the literature review.

The third chapter focuses on the methods of investigation used in this study. Detailed descriptions of the procedures, the sample, and the measures of assessment are provided. Chapter four presents the results of the statistical analyses used to address each of the hypotheses presented in chapter two. Finally, chapter five deals with the discussion of the results in light of the current scientific literature. Suggestions for future research are also presented.

Chapter II

Literature Review

Normal Cognitive Aging

Developmental research indicates that normal cognitive aging is variable: some abilities decline with age, others are maintained and some abilities improve over time (Baltes, 1987). The patterns of cognitive change associated with normal aging are not global, nor universal. The ambiguity of the research on cognitive aging indicates that, on the one hand, it is common for healthy individuals in their 80s to score within the normal range on a wide variety of psychometric tasks (Benton, Eslinger, & Damasio, 1981). Schaie (1990) reports that over 50% of study participants over the age of 81 years maintained or improved their level of functioning on four of the five cognitive measures in a longitudinal study spanning seven years.

On the other hand, advancing age increases the probability of cognitive loss. The average performance on both fluid (abilities needed to master novel experience) and crystallized (knowledge gained from cultural experience) psychometric tasks generally begins to decline in the seventh decade (Schaie, 1990). Fluid abilities appear to be more sensitive to age-associated change, with decrements noted at an earlier age than in crystallized abilities (Ryan, Paolo & Brungardt, 1990a; Schaie, 1990).

This pattern of cognitive development is reflected in

the Verbal and Performance subscales of the Wechsler Adult Intelligence Scale (WAIS). The WAIS is a commonly used measure of intelligence. It is composed of two subscales, the subscale of Verbal Intelligence (VIQ) contains six subtests measuring general reasoning abilities based on language; (a) Information, (b) Digit Span, (c) Vocabulary, (d) Arithmetic, (e) Comprehension, and (f) Similarities. The subscale of Performance Intelligence (PIQ) has five subtests which are designed to measure nonverbal reasoning abilities; (a) Picture Completion, (b) Picture Arrangement, (c) Block Design, (d) Object Assembly, (e) Digit Symbol.

Subtests comprising the VIQ subscale test areas of general knowledge, language and reasoning that have been acquired throughout a lifetime, providing a measure of crystallized intelligence (Spreen & Strauss, 1991). The PIQ subtests measure the ability to master novel tasks in an efficient manner, thus providing a psychometric measure of fluid abilities (Spreen & Strauss, 1991). Adults below the age of 74 years tend to maintain stable scores or improve on verbal and arithmetic tasks, thought to measure crystallized intelligence, while showing declines in the Digit Symbol Substitution, Block Design and Object Assembly tasks, which can be considered measures of fluid abilities (Botwinick, 1977; Horn & Donaldson, 1976; Kramer & Jarvik, 1979).

The age-corrected scaled scores found in the Wechsler Adult Intelligence Scale-Revised (WAIS-R) manual attempt to

compensate for these normative changes, with the increments in scaled scores beyond the comparison group of age 20 to 34 increasing more rapidly for the PIQ than the VIQ subscale (Sattler, 1982). In addition, the Digit Symbol subtest of the PIQ subscale typically shows the greatest decline with advanced age (Sattler, 1982).

In a study aimed at extending the WAIS-R norms past the age of 74, Ryan, Paolo and Brungardt (1990a) found a continuation in this pattern of cognitive performance. People over age 80 scored 4.84 points lower than the age-corrected norms for 70 to 74 year olds on the VIQ subscale and 8.53 points lower on the PIQ subscale. Factor analytic studies further suggest that with advanced age verbal skills may be relied on to compensate for deficits in non-verbal reasoning, possibly reducing the effects of decline in this area (Ryan, Paolo, & Brungardt, 1990b). While these results indicate extensive decline on tasks measuring aspects of the fluid abilities of adults over 80 years old, they are based on cross-sectional designs which have a limited ability to assess change.

The patterns of cognitive changes associated with age tend to show more stability in longitudinal research using selected WAIS-R subtests. Botwinick, Storandt, and Berg (1986), found that healthy adults between the age of 64 and 81 years maintained consistent scores over a four year period on the WAIS-R subtests of Information and

Comprehension from the VIQ subscale, and the Digit Symbol and Block Design subtests from the PIQ subscale. As the normal subjects in this study were screened for a variety of illnesses, the authors concluded that the results were due to the selection process and not likely to be replicated.

Research investigating the scoring patterns of elderly adults over the age of 74 years is limited, with most studies relying on cross-sectional designs. A factor analysis of the WAIS-R scores for an elderly sample shows that the VIQ and the PIQ subscales form distinct components (e.g., load on separate factors) measuring a single underlying factor of general intelligence, although the relationship of specific subtests to measured general intelligence appears to alter with age (Ryan et al., 1990b). Further longitudinal research is needed to determine if the declines in the scores of the VIQ and the PIQ subscales of the WAIS-R are primarily an artifact of research design, or whether the WAIS-R performance of healthy individuals over the age of 75 shows the systematic decline suggested in the studies using a cross-sectional design.

Cognitive Aging and Alzheimer's Disease

The prevalence of AD, the most common dementing disorder, increases dramatically with age, from a rate of 3.0% in those between the ages of 65 and 74 years, to 23% in people between the ages of 75 to 84, and over 47% in adults older than 85 years of age (Evans et al., 1989). AD is

characterized primarily by memory impairment and word finding problems in the early stages, with deficits of semantic language and perception evident as the disease progresses (Hill, Storandt, & LaBarge, 1992; Joynt & Shoulson, 1985). Cognitive decline is progressive, although the rate of decline shows a high degree of intraindividual variability (Barr, Grandt, Carson, & Folstein, 1992; Teri, Hughes, & Larson, 1990). The extensive decline in cognitive abilities, impairing social and occupational functioning, characteristic of AD (American Psychiatric Association, 1980) and the similarities in structural brain changes between healthy and AD elderly adults have led to the hypothesis that AD represents an extreme point on the continuum of age-associated decline (Brayn & Calloway, 1988).

Typically, adults with AD exhibit well preserved social habits long after other cognitive skills have degenerated. As social skills rely predominately on crystallized abilities it is not surprising that early in the disease AD research participants tend to score higher on general measures of verbal abilities, such as the VIQ, while showing declining ability to deal with the novel tasks as measured by the PIQ subscale of the WAIS-R (Fuld, 1984; Gfeller & Rankin, 1991; Lezak, 1983).

In an attempt to extend this general pattern of results, Fuld (1984) identified a WAIS-R profile of the

diagnostic indicators of AD. In the Fuld AD profile the highest scores are obtained on Information and Vocabulary, followed by scores on Similarities and Digit Span. These subtests are four of the six that compose the VIQ subscale. Of the PIQ subtests, the profile suggests that AD patients score higher on Object Assembly than Digit Symbol and Block Design, but the Object Assembly score is lower than Vocabulary and Information scores. Fuld (1984) found this profile to be effective in distinguishing AD from other forms of dementia. Other investigators, however, have not reached the same conclusions, as the profile tends to occur infrequently in both normal and demented population (Filley, Kobayashi, & Heaton, 1987; Gfeller & Rankin, 1991; Logsdon, Teri, Williams, Vitiello, & Prinz, 1989; Tuokko & Crockett, 1987). The similarities in the WAIS-R scoring patterns of the healthy and AD subjects in these samples supports the continuum hypotheses of Brayn and Calloway (1988). While AD patients achieve lower scores on WAIS-R tasks than healthy individuals in general, the relative ranking of the VIQ and PIQ scores remains stable, with VIQ scores relatively higher than PIQ scores.

Over a four year period Botwinick and colleagues (1986) found that the scores of AD subjects declined significantly on all tests of memory and intelligence, with Digit Symbol scores declining 73%, second only to the declines found on a task measuring the ability to remember short stories after a

delay. As with healthy elderly adults, the Digit Symbol subtest appears to be the most sensitive of the WAIS-R subtests in detecting declines in fluid abilities over time (Sattler, 1982).

Many clinicians have found the Mini-Mental State Exam (MMSE: Folstein, Folstein, & McHugh, 1975) to be a sensitive tool for assessing global intelligence in elderly patients with AD (Bleecker, Bolla-Wilson, Kawas, & Agnew, 1988; Farber, Schmitt, & Logue, 1988; Folstein et al., 1975). As the MMSE provides only a brief assessment of several cognitive areas based primarily on verbal responses, it is not useful for evaluating differential change in fluid and crystallized intelligence. However, it is a reliable tool for differentiating between healthy and demented patients (Folstein et al., 1975).

Farber et al. (1988) found the MMSE to be moderately correlated with the WAIS Full Scale IQ (r = .83) in a sample of AD patients. A cut-off score of 24 was established as an indication of dementia (Farber et al., 1988). Comparing MMSE scores of healthy and AD subjects Reisberg and colleagues (1986) established a system of rating cognitive abilities in terms of MMSE scores. Adults scoring in the range of 16-23 were identified as early AD, and those scoring in the range of 20-27 were categorized as in the border between benign senescent forgetfulness and early AD. As 75% of healthy adults score at or near ceiling level on

the MMSE, Bleecker et al. (1988) suggested a cut-off score of 26 for adults in their eighth decade. Overall, there is a consensus that MMSE scores of less than 24 are suggestive of cognitive deficits, while those above 27 likely indicate normal cognitive abilities. Further research employing a longitudinal design are needed to assess the sensitivity of the MMSE to intraindividual change in very old adults who are healthy, as well as those who are diagnosed with AD.

Strategies of Memory Compensation

To this point, most of the research discussed has agreed that aging is associated with cognitive decline to some degree, although the rate and extent of decline are variable (Dixon, 1992; Schaie, 1990). The ability to compensate for cognitive decrements in one area with the intact abilities of another are a possibility that has been suggested by a number of researchers. For example, Salthouse (1984) showed that older typists maintain a typing speed comparable to that of younger typists by looking further ahead in the document they are typing, thus compensating for slow processing speed. As discussed earlier, Ryan and his colleagues (1990b) suggested that very old adults relied on intact verbal abilities to compensate for declines in nonverbal reasoning, as measured by the PIQ. The ability to compensate for declines suggests a mechanism whereby deficits in the ability to cope with novel tasks may not be apparent in the course of everyday functioning.

To clarify the concept of compensation the following definition developed by Bäckman and Dixon (1992) will be adopted in the current study.

> Compensation can be inferred when an objective or perceived mismatch between accessible skills and environmental demands is counterbalanced (either automatically or deliberately) by investment of more time or effort (drawing on normal skills), utilization of latent (but normally inactive) skills, or acquisition of new skills, such that a change in the behavioral profile occurs, either in the direction of adaptive attainment, maintenance, or surpassing of "normal" levels of proficiency, or maladaptive outcome behaviors or consequences. (p. 272)

There are two ideas implicit in this definition: (a) in cognitive aging one area of maintained ability is used to compensate for objective or perceived declines in other areas of cognition to achieve a balance between the demands of the environment, personal expectations and behaviour (Dixon & Bäckman, in press); and (b) the ability to compensate for deficits requires an awareness of the mismatch between environmental demands and skill level, thereby relating an understanding and beliefs regarding functioning to daily performance (Dixon, 1989).

Cavanaugh (1989) outlines three types of awareness that are active in memory compensation, (a) systemic awareness,

(b) epistemic awareness, and (c) on-line awareness. Systemic awareness refers to metamemory, or awareness of how human memory functions and specifically an awareness of one's own memory function and capacity (Dixon, 1989). Epistemic awareness describes the ability to judge how one's personal memory ability matches the demands of the environment and whether changes in memory ability require behavioral changes to maximize memory performance. On-line awareness refers to the moment to moment memory monitoring to determine the effectiveness of memory performance. Theoretically, there may be a dissociation between the level of explicit verbal awareness of deficits and behavioral expressions of deficit awareness, such as the use of compensatory mechanisms (Feher, Larrabee, & Crook, 1992). Thus, the use of compensatory mechanisms does not necessarily require the ability to provide an explicit verbal report of all areas of perceived deficits.

Clearly, different research methods of compensation focus on one area of awareness more than another (see Dixon & Backman, in press for a review). The literature reviewed from this point will focus on questionnaire methods of investigation in the use of compensation strategies in memory, thus examining systemic and/or epistemic awareness as necessary components of compensation.

Recent research has shown that elderly people commonly rely on memory strategies, possibly to help them compensate

for real or perceived memory deficits (Reeves & Dobbs, 1992). In addition, specific types of strategies appear to be preferred, with external memory aids, such as notes and lists reportedly used to a greater extent than internal methods of mnemonics (Jackson, Bogers, & Kerstholt, 1988).

While the body of research regarding the use of memory strategies is growing, the research examining the use of memory strategies by individuals diagnosed with AD is limited, despite the possibilities that this knowledge could be used to facilitate cognitive rehabilitation programs. In addition, research is needed to examine longitudinal changes in the use of memory aids by very old adults, and whether changes in the reported use of memory aids parallels changes in cognitive performance.

Awareness of Deficit and General Intelligence

The literature reviewed to this point indicates that both AD and healthy elderly adults are likely to experience some degree of cognitive deficit, ranging from minor to severe. As the concept of compensation is assumed to be directly related to awareness, research indicating that older adults are capable of compensating for deficits suggests that they are aware of the mismatch between environmental demands and their ability to effectively satisfy those demands (Dixon, 1989; Reeves & Dobbs, 1992). Levine (1990) contends that awareness of deficits requires the ability to reason and make inferences, as well as the

ability to learn new information. As would be expected, impaired deficit awareness is a common finding in many neurological disorders, such as dementia where these abilities are impaired (McGlynn & Kaszniak, 1990). While these studies reflect the possibility that awareness of cognitive functioning is related to intellectual ability little research has assessed this relationship in healthy elderly adults.

Studies investigating awareness of deficit in AD patients generally find a decline in the level of awareness with progression of the disease, despite the large range of interindividual variability in demented individuals (McGlynn & Schacter, 1989). In a parallel manner, AD patients often exhibit an inverse relationship between the degree of cognitive impairment and depression, with the least impaired patients showing the highest level of depression (Burns et al., 1990; Pearson, Teri, Reifler, Burton, & Raskind, 1989; Reisberg, Ferris, Borenstein, Sinaiko, de Leon, & Buttinger, 1986). Studies indicating a higher reported level of depression at the stage of AD when patients are likely to be aware of their declining cognitive abilities suggest a relation between general intelligence and awareness, such that the perception of cognitive difficulties may contribute to feelings of dysphoria (Burns et al., 1992; Pearson et al., 1989). Further research is needed to investigate the relation between general intelligence, deficit awareness,

and depression.

Cognitive Aging and Depression

With increased age individuals become more susceptible to chronic and acute illness which may contribute to an increased rate of cognitive decline (Schaie, 1990). Deficits in cognitive or physical functioning, including organic brain disorders, have been found to coincide with increased levels of depression (Addington, 1986). Although diagnosing clinical depression in an elderly population is problematic, it is estimated that approximately 15% of community dwelling elderly adults in the United States have substantial depressive symptoms (Blazer & Williams, 1980).

The literature suggests that depression has a negative impact on specific cognitive processes (Abram, Redfiedl, & Taylor, 1981; Calev & Erwin, 1985; Weingartner & Silberman, 1984; see Sackeim & Steif, 1988 for a review) such as short-term memory (Bornstein, Baker, & Douglass, 1991). The characteristics of short-memory deficits experienced by depressed patients are similar across the lifespan (Niederehe, 1986). Memory deficits are generally of concern to depressed patients, suggesting that accurate self-monitoring of memory function is maintained throughout the illness (Niederehe, 1986).

While depression has a negative impact on specific cognitive abilities, researchers have not yet determined the global influence of depression on the cognitive abilities of

very old adults (Donnelly, Murphy, Goodwin, & Waldman, 1982; Miller, 1975). A large body of research indicates that from childhood to adult middle-age, deficits are usually found in the WAIS-R PIQ scores of people who have experienced depressive episodes (Sackeim, Freeman, McElhiney, Coleman, Prudic, & Devanand, 1992; see Kluger & Goldberg, 1990, for a review). Further research is necessary to assess the impact of depression on cognitive abilities later in life.

As is common with many cognitive disorders when self-awareness and social orientation are preserved, AD patients may also experience depressive symptoms (Cohn & Neuman, 1978). While depression is not as common in AD as it is in subcortical dementing illness, late-onset depression may be an early marker of AD (Lezak, 1983). Reifler and Larson (1988) report that 20-30% of AD patients present with depressive symptoms.

Depression in AD tends to occur more frequently in the early stages of the illness. Burns and his colleagues (1990) found that AD patients scoring higher on the Mini Mental Status Exam (MMSE: Folstein, Folstein, & McHugh, 1976) reported more depressive symptoms than those scoring at a lower level. However, in the same study observer-rated depression scores did not vary between the groups. The discrepancy between self-report and observer-rated depression scores highlights the problem of interpreting behaviour in this population.

It has been suggested that the dichotomy of depressed and non-depressed AD patients is an indication of two different sub-types of AD (Rovner, Broadhead & Spencer, 1989). Similarities in the rate of cognitive decline in depressed and non-depressed demented patients over the course of one year does not support this view (Burns, Jacoby, & Levy, 1990; Lopez, Boller, Becker, Miller, & Reynolds, 1990).

As the rate of decline in cognitive abilities is variable throughout the course of AD, it must be considered that the coexistence of depression and cognitive decline may exacerbate the symptomology of each condition, resulting in excess disability (Barr et al., 1992; Reifler et al., 1988; Teri et al., 1990). The pattern of WAIS-R scores lends support for the theory of excess disability, as deficits in cognitive functioning are greater in Performance IQ in depressed than in non-depressed AD patients (Gfeller & Margolis, 1990), similar to the findings reported earlier for healthy, depressed adults (e.g., Kluger et al., 1990).

Summary

Research suggests that there are similarities in the types of deficits experienced by very old adults who are healthy, those diagnosed with AD and those who are depressed. First, healthy, nondepressed very old adults show greater declines on the PIQ subscale than the VIQ, (Sattler, 1982). Second, healthy depressed adults reflect

similar deficits in WAIS-R scores, although they show a greater severity of deficits than nondepressed, healthy adults (Kluger et al., 1990). Third, nondepressed AD subjects also show a similar pattern of results, but the PIQ score is lower than that of patients who are only diagnosed as depressed (Lezak, 1983). Finally, depressed subjects also diagnosed with AD exhibit the greatest degree of deficit on PIQ measures relative to VIQ scoring (Gfeller & Margolis, 1990). Further research is needed to assess the parallels between the patterns of cognitive changes associated with depression and those related to the normal process of aging in very old adults.

Goals of the Study

The present study has four main goals. The first is to examine the differential performance of healthy and demented very old adults on the VIQ, the PIQ and the MMSE tests of intelligence. It is expected that the AD group will score lower on the MMSE and the WAIS-R subscales than the healthy group, particularly on the PIQ scale of the WAIS-R. The PIQ/VIQ ratio is expected to be smaller for the AD participants than the healthy participants.

The consistency of performance on the intelligence tests over the course of the study is also of interest. It is expected that the performance of the healthy group will show little change over the two year period and the PIQ/VIQ ratio will also remain constant. The AD group is expected

to have greater declines on all cognitive measures than the healthy group. The PIQ/VIQ ratio is expected to show little change over time, reflecting declines in the VIQ tasks of the WAIS-R, as well as the PIQ tasks.

The second goal of the study is to investigate the use of compensatory memory strategies in this sample. It is expected that healthy adults will report greater use of memory strategies at the initial assessment than those diagnosed as AD. The use of memory strategies by healthy adults is expected to increase over the two years of the study. In contrast, the reported use of strategies by AD participants is expected to show a decline parallel to the reduction in cognitive abilities. In view of the literature (e.g., Reeves & Dobbs, 1992), it is also expected that both healthy and AD participants will report greater use of externally based strategies than internal memory strategies.

The third goal of the study is to investigate the relationship between general intelligence and awareness of cognitive abilities. Specifically, the question of whether general intelligence is related to the level of deficit awareness in healthy and demented very old adults will be investigated. The literature suggests that participants with low scores on intelligence measures are likely to have reduced insight into the degree of cognitive dysfunction, in contrast to those with higher intelligence scores. Therefore, it is expected that healthy participants will

have greater insight regarding memory functioning than AD participants. Further, it is a common finding that functional impairment often leads to feelings of dysphoria (Lezak, 1983). Therefore, a greater awareness of memory impairment is expected to be related to higher levels of depressive symptoms.

The fourth goal of the study is to examine the effects of depression on the intelligence test performance of healthy and AD elderly adults. It is expected that depressed healthy individuals will score lower on PIQ measures than nondepressed healthy subjects, while the VIQ score is not expected to be significantly different between these two groups. Depressed AD participants are also expected to show a decline on PIQ scores relative to the nondepressed AD sample, while the VIQ scores are not expected to differ significantly from this reference group.

Chapter III

Method

Participants

The entire population of 2368 adults over the age of 75 years from the Kungsholmen parish in Stockholm, Sweden, were interviewed in 1987 as Phase 1 of a study designed to investigate the incidence and prevalence of disease resulting in dementia. Study participants were screened using multiple measures (e.g., social interview, multiaxial medical diagnosis, and cognitive assessment).

In Phase 2, 380 individuals scoring less than 24 on the MMSE (Folstein et al., 1975) were matched with 354 controls who scored 24 or more on the MMSE. Of those scoring less than 24 on the MMSE, 66 died or became untestable between Phase 1 and Phase 2. Thus, the sample in Phase 2 consisted of 314 participants with a diagnosis of suspected dementia and 354 healthy control participants (N = 668). Participants in the current study were drawn from this sample of 668 adults. Because the first goal was to obtain a sample of relatively cognitively intact adults between the ages of 75 and 85 (as of October, 1987) only those born between 1902 and 1912 with a MMSE score greater than 20 were included. A second goal was to select participants who were relatively free of disabilities that could affect test results. Participants with the following physical conditions were excluded from the study: (a) severe

cardiovascular disease, (b) liver, kidney or lung dysfunction, (c) neurological or psychiatric disorders, (d) severe visual or auditory deficits, (e) hypothyroidism, (f) vitamin B-12 deficiency, or (g) participants who used anticholinergic drugs. As testing was conducted in a research facility participants unable to present for testing due to physical disabilities were also excluded.

The current study included 106 individuals meeting these criteria. At the initial assessment (Occasion 1) 95 participants were classified as healthy and 11 were diagnosed with probable AD according to NINCDS/ADRDA criteria (McKhann, Drachman, Folstein, Katzman, Price, & Stadlan, 1984). This subsample will be referred to as Subsample 1 in further discussion. The sample characteristics for Subsample 1 at the first occasion of assessment are shown in Table 1.

As there were five occasions of measurement at six month intervals some participants shifted status (healthy to probable AD), or failed to return for one or more testing sessions. Changes in the sample at each occasion of measurement are shown in Figure 1. Following the first occasion of data collection in the present study 19 healthy participants were randomly selected from the sample for participation in an independent pharmacological study, and two demented participants became unavailable for testing. At Occasion 2 one healthy participant was reclassified as

probable AD. Thus, on Occasion 2 the sample (N = 85) included 75 healthy and 10 AD participants, ranging in age from 77 to 87 years. At the time of Occasion 3 (N =78) 11 healthy and three AD participants failed to return for testing. In addition, seven healthy participants who were unavailable for testing on Occasion 2 were successfully retested on Occasion 3. The resulting sample of 71 healthy and seven AD participants completed the 3rd occasion of testing. Occasion 4 was completed by 83 participants, 65 healthy and 18 AD. Seven healthy participants were unavailable for the fourth assessment. A follow-up medical examination carried out on Occasion 4 reclassified nine healthy participants as probable AD, in addition two AD participants and two healthy participants who failed to complete Occasion 3 were successfully included in the fourth assessment. At Occasion 5 (N = 79) 63 healthy and 16 AD participants were retested. Five healthy and two AD participants failed to return for testing following Occasion 4 and three healthy participants who were unavailable for testing on Occasion 4 were included in the fifth occasion of data collection.

Insert Figure 1 about here

Given this changing sample composition over the five assessment occasions, careful delineation of subsamples

targeted in various analyses is required. Five subsamples were defined. The characteristics of each sample at Occasion 1 is presented in Table 1. Subsample 1 is the sample of healthy and AD participants as it was defined by the original diagnosis. At the first occasion of assessment the healthy group of participants included those who would be diagnosed with AD six months later, on Occasion 2 or 18 months later, on Occasion 4 (see Figure 1). As the healthy group in Subsample 1 included those who would later be diagnosed with AD, this sample was not used in any major analyses. In Subsample 2, the healthy subjects are defined as those who maintained a healthy diagnosis throughout the five occasions, with those who would be later diagnosed as demented removed from the healthy sample. The AD subjects are defined as those who were diagnosed as demented on Occasion 1. In addition, those who were diagnosed with AD at Occasions 2 and 4 were removed from the healthy sample and added to the demented group. This creates a sample of 85 healthy and 21 AD subjects, with Occasion 1 defined as the first occasion of assessment following diagnosis (e.g., Occasion 4 would be classified as Occasion 1 following diagnosis for subjects who were diagnosed with AD on Occasion 4). This sample is appropriate for analyzing some questions concerning group differences on one occasion.

Insert Table 1 about here

Subsample 3 is defined as an extension of Subsample 2, with the provision that only subjects who were present over two occasions following diagnosis were included. The subjects in the healthy group were never diagnosed with AD during the study and were present on Occasions 1 and 2. The AD sample includes participants who were diagnosed as AD at the initial assessment, and were also present on Occasions 1 and 2. As well, the subjects diagnosed as AD on Occasions 2 and 4 were classified as AD, with the occasion of diagnosis designated as Occasion 1. Participants in the pooled AD sample were included in Subsample 3 if they were present on the occasion of their diagnosis, as well as the occasion following their diagnosis of AD.

Subsample 4 defined the healthy participants as those who were never diagnosed with AD at any time during the study. The demented subjects were those who were diagnosed at the initial assessment. The participants who were diagnosed as AD on Occasion 2 or Occasion 4 are not included in this sample. All participants in Subsample 4 were present for all five occasions. Subsample 5 included the healthy subjects who were never diagnosed with AD at any time during the during study. The demented sample in Subsample 5 varies across occasions to include AD

participants on the occasion they were diagnosed with AD. Specifically, the AD sample at Occasion 1 only includes those who were diagnosed with AD at the initial assessment. The subject diagnosed with AD on Occasions 2 enters Subsample 5 as part of the AD sample on Occasion 2. Similarly, those who were diagnosed with AD on Occasion 4 are included in Subsample 5 as AD subjects at Occasion 4. Subsample 5 is useful for comparisons of groups or variables on specific occasions.

Measures

Four assessment measures were used in the study: (a) the Mini-Mental State Exam (MMSE: Folstein et al., 1975); (b) selected subtests from the Wechsler Adult Intelligence Scale-Revised (WAIS-R: Wechsler, 1981); (c) selected items from the Comprehensive Psychopathology Rating Scale (CPRS: Asberg, Schalling, & Sedvall, 1978); and (d) the Compensation Questionnaire (CQ: Dixon & Bäckman, in press).

MMSE. The MMSE (Folstein et al., 1975) is a well-established brief exam of 11 questions assessing general cognitive functioning, areas of orientation, attention/concentration, memory, praxis and language. The MMSE is scored on a scale from 0 (lowest) to 30 (highest level of cognitive functioning). The brief nature of the MMSE makes it particularly well suited to this study where it is desirable to obtain multiple measures within a short

period of time to avoid overtaxing the elderly participants. The MMSE has a reported 24 hour test-retest reliability of r = .89 (Folstein et al., 1975) with depressed inpatients, and a 28 day retest reliability of r = .99 with demented inpatients. However, Olin and Zelinski (1991) found the psychometric properties of the MMSE to be less reliable with healthy subjects (mean age of 71.24, SD = 5.96) over a one year period, reporting a test-retest correlation of r = .34.

WAIS-R. The WAIS-R (Wechsler, 1981) is a standardized comprehensive test of intelligence. The WAIS-R is a widely used and reliable assessment tool with reported subtest split-half reliability coefficients ranging from r = .66 (Picture Arrangement) to r = .90 (Picture Completion); Verbal and Performance subscales of r = .95 and r = .94 respectively, in a sample of normal elderly North Americans 80 years of age and over (Ryan et al., 1990a). The scores from the WAIS-R were scaled without adjustment for age (Wechsler, 1981). In a younger sample (mean age of 67.1 years) the one year test-retest coefficients ranged from r = .65 for Picture Completion to r = .91 for Digit Symbol (Snow, Tierney, Zorzitto, Fisher, & Reid, 1989). Snow and his colleagues (1989) report high retest reliability for the VIQ (r = .86) and the PIQ (r = .85) subscales.

The traditional two-factor model of WAIS-R subtests, forming the Verbal and Performance subscales has been shown to reliably capture the underlying factors of measured

intelligence in a sample of healthy older adults (Ryan et al., 1990b; Smith, Ivnik, Malec, Petersen, & Tangalos, 1992). This study includes three subtests from the Verbal subscale, Information, Digit Span, and Similarities, as well as four subtests from the Performance subscale, Block Design, Picture Completion, Picture Arrangement and Digit Symbol Substitution.

CPRS. The CPRS (Asberg et al., 1978) is a pool of items designed to assess different aspects of psychopathology. A unique aspect of the CPRS is the accommodation of two rating systems, one rating the self-reported symptoms of the study participants (e.g., reported feelings of sadness) and the other rating observed signs (e.g., observed sad affect). Items are scored on a scale indicating absence of symptom (0), possible pathology (1), probable pathology (2), and extreme pathology (3). Specifically of interest in the present study are items designed to assess depressive symptoms and a measure of observer-rated awareness of cognitive deficits. Several of the depression items have been used in previous research (e.g., Martinsen, Friis, & Hoffart, 1989; Montgomery & Asberg, 1979; Perris, Eisemann, von Knorring, & Perris, 1984). The items selected for this study do not replicate existing CPRS depression scales. Instead, a new scale consisting of nine self-reported and three observer-rated items from the original CPRS item pool, as well as two

additional self-report items from the Perris et al., (1984) scale will be used to reflect the criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R: American Psychiatric Association, 1987) for depressive symptoms. A description of the 14-item depression scale and scoring criteria is shown in Table 2.

Insert Table 2 about here

The scale reflecting DSM-III-R criteria for major depression was established through the following item selection process. First, a description of each CPRS item included in the assessment was reviewed to select items measuring depressive symptoms. Second, in consultation with a clinical psychologist, items were matched as closely as possible to the diagnostic criteria for major depression established in the DSM-III-R. All items relevant to the diagnostic criteria were included in the scale. The Cronbach's coefficient alpha ranged from .58 to .88 with healthy participants over the five occasions of the present study.

To determine a scoring of depressive symptoms similar to DSM-III-R a method described in Radloff's (1991) scoring of the Center for Epidemiologic Studies Depression Scale was used. This method is only approximate since the CPRS lacked a measure of energy level and does not include a time frame

for symptom duration. Part A, including items measuring dysphoric mood, was scored separately from Part B, which included items measuring other symptoms of depression (e.g., somatic, suicidal thought) (see Table 2). Positive responses were required for both Part A and Part B for an individual to be considered as presenting significant depressive symptoms.

CQ. The CQ (Dixon and Bäckman, in press) is a theory-based instrument developed to provide a reliable tool for collecting general information on the forms and mechanisms of memory compensation resulting from an awareness of memory deficit in daily life. This self-report measure consists of 45-items providing six scales measuring forms of memory compensation and a seventh scale designed to assess the degree of changes over the last five to ten years in each of these six areas. Examples of the seven scales are shown in Table 3. The CQ shows a high degree of internal consistency with healthy study participants over the five waves of data collection in the present study (Cronbach's alpha ranging from .86 to .93).

Insert Table 3 about here

Procedure

All study participants were tested in Stockholm, Sweden. The design of the present study included five

assessment occasions at six month intervals to provide a longitudinal assessment of cognitive functioning and mood. Testing was conducted in (a) Fall 1989 (Occasion 1), (b) Spring 1990 (Occasion 2), (c) Fall 1990 (Occasion 3), (d) Spring 1991 (Occasion 4), and (e) Fall 1991 (Occasion 5). The design of the study, over the two year period of assessments, is shown in Table 4.

Insert Table 4 about here

As Table 4 indicates, the MMSE, the CPRS and the CQ were administered on each assessment occasion (five occasions). To reduce training effects the WAIS-R was administered only on occasions one, three, and five allowing a one year period between retests.

Chapter IV

Results

The objectives for the statistical analysis of the present study are (a) to examine the measurement characteristics of the four instruments across multiple occasions in two samples, (b) to examine group differences occurring over a two year time-span in the intelligence scores of very old, community dwelling research participants who were diagnosed as healthy or as probable AD, (c) to investigate the use of compensatory memory strategies in this sample, and (d) to assess the relations between scores of intelligence, depressive symptoms and awareness of cognitive decline.

Reliability Analysis

The initial set of analyses examined the psychometric characteristics of the WAIS-R, the MMSE, the CQ and the CPRS. Two indicators of reliability were used: (a) Cronbach's alpha, an indicator of internal consistency, and (b) Pearson-R test-retest correlations.

WAIS-R. The internal consistencies of the abbreviated Verbal and Performance scales of the WAIS-R for Subsample 2 were examined on the three occasions they were measured. The Cronbach's alpha for the healthy participants was .68 at Occasion 1, .75 at Occasion 3, and .80 at Occasion 5 for the Verbal scale. Cronbach's alpha for the Performance scale

was .77 at Occasion 1, .87 at Occasion 3, and .82 at Occasion 5.

Occasion 1 of Subsample 2 provided the only occasion of measurement with sufficient number of AD participants to calculate Cronbach's alpha for the WAIS-R scales. The Cronbach's alpha for AD participants was .53 for the Verbal scale and .77 for the Performance scale.

The test-retest reliability of the abbreviated WAIS-R subscales and individual tests were examined with the healthy participants in Subsample 4. The results presented in Table 5 show that the two year test-retest reliability of the VIQ (r = .80) and the PIQ (r = .84) for the healthy participants were acceptably high. The test-retest reliability correlations of the individual subtests over the two year period for the healthy participants ranged from r = .33 for Picture Arrangement to r = .86 for Information.

Insert Table 5 about here

MMSE. The test-retest reliability over five occasions for the MMSE in Subsample 4 is shown in Table 6. Over the two year period for the healthy participants the correlation was r = .66. The correlations over the six month period between Occasions 1 and 2 were r = .79 for the healthy participants and r = .54 for the AD participants.

Insert Table 6 about here

CQ. The internal consistencies (Cronbach's alpha) of the CQ subscales for the healthy and demented participants as defined by Subsample 2 are shown in Table 7. Overall, a pattern of moderate to high internal consistency is shown for healthy and AD participants across the seven subscales. The Cronbach's alpha for the total CQ, excluding the Change subscale, across the five occasions ranged from .85 to .92 for the healthy participants. The Cronbach's alpha for the AD participants was .91 on Occasion 1 and .86 on Occasion 2.

Insert Table 7 about here

The test-retest correlations of the CQ subscales over the two year assessment period (Occasions 1 - 5) ranged from r = .32 for the Change subscale to r = .70 for the External subscale for the healthy participants. The test-retest correlations for the interval between Occasions 1 and 2 ranged from r = .41 (Effort) to r = .79 (Internal) for the healthy participants, and r = .29 (Time) to r = .74 (Success) for the AD participants. All reliability coefficients are shown in Table 8.

Insert Table 8 about here

CPRS. The Cronbach's alpha of the CPRS DSM-based depression scale for the healthy and AD participants, as shown in Table 9, ranged from moderate to high across the five occasions for the healthy participants. As shown in Table 10 the test-retest correlation for the healthy participants over the two year period (Occasions 1 - 5) was r = .52. The test-retest correlation over the six month interval between Occasions 1 and 2 for Subsample 3 of the AD participants was minimal (r = .09).

Insert Tables 9 and 10 about here

Group Differences in Intelligence Test Performance

VIQ and PIQ subscales. The hypothesis that the healthy participants in this study would score higher on the VIQ and PIQ subscales of the WAIS-R than the demented participants was supported in these analyses. The scores from Subsample 2, with those who would later be diagnosed with AD removed from the healthy group and added to the pooled group of participants with a diagnosis of AD, were used in this analysis. To examine the effects of diagnosis (healthy and AD) on the VIQ and PIQ subscales from Occasion 1, a multivariate analysis of variance (MANOVA) was conducted.

As the intelligence scores of the participants diagnosed as AD on Occasions 1 (n = 11) and 4 (n = 9) were not significantly different, t = -.89, p > .05, these data were combined to represent the first occasion of measurement following diagnosis. The between-subjects MANOVA indicated a significant effect for Diagnosis, Wilks' $F(2,99)$ = 16.70, p < .001. As expected, the healthy subjects scored significantly higher on both the PIQ (M = 24.47, SD = 6.12) and the VIQ (M = 27.69, SD = 5.76) than did the AD subjects (PIQ M = 16.00, SD = 5.28; VIQ M = 20.00, SD = 4.58, respectively).

The consistency of the performance of the healthy and AD groups on the VIQ and the PIQ measures was also of interest. It was hypothesized that the performance of the healthy group would show little change over the two year period, while the VIQ and the PIQ scores of the AD group would show significant decline. The data from Subsample 4, providing diagnostically uniform groups of healthy and AD participants over three occasions, were used in this analysis. To investigate the effects of diagnosis across the three occasions on the VIQ and PIQ subscale scores, a 2 x 3 (Diagnosis x Occasion) MANOVA, with repeated measures on the last factor was done. The results indicated a significant effect for Diagnosis, Wilks' $F(2,43)$ = 7.36, p < .002, but the Occasion effect was not significant, Wilks' $F(4,41)$ = 1.71, p > .05. The Diagnosis x Occasion

interaction was significant, Wilks' $F(4,41) = 2.65$, $p < .05$.

Follow-up univariate analyses of variance (ANOVAs) were done separately on both the VIQ and PIQ subscale scores with the means shown in Table 11. A Bonferroni correction established the significance level at .01. With the VIQ scores there was a significant effect for Diagnosis, $F(1,44) = 14.79$, $p < .001$, $MSe = 105.51$; and a significant Diagnosis x Occasion interaction, $F(1,44) = 8.07$, $p < .007$, $MSe = 7.83$. Healthy participants scored higher than AD participants across occasions. As shown in Figure 2, the interaction was due to a greater mean difference between healthy and AD participants at Occasion 5 than at Occasion 1, as the scores of the AD participants declined.

Insert Figure 2 about here

The follow-up ANOVA for the PIQ subscale, with a Bonferroni corrected level of significance set at .01, indicated a reliable main effect for Diagnosis, $F(1,44) = 7.87$, $p < .007$, $MSe = 122.67$, but the Occasion effect and the Diagnosis x Occasion interaction were not significant. The PIQ scores are plotted in Figure 2 for comparison purposes. Across occasions the healthy participants scored higher than the AD participants.

Insert Table 11 about here

As the number of participants in each diagnostic group was unequal, a group of healthy participants (n = 10) was matched to the AD group (n = 5) of Subsample 4. The matching was done by independent raters on the demographic variables of age, education and gender. The test-retest correlations of the matched healthy group for the PIQ and VIQ WAIS-R measures was similar to that of the original group. As with the larger group, it was expected that the VIQ and the PIQ scores of the healthy group would remain constant over the three occasions and the scores of the AD group would show decline. To examine the effect of diagnosis on the VIQ and PIQ subscales across the three occasions two independent 2 x 3 (Diagnosis x Occasion) MANOVAs were done, with repeated measures on the last factor.

The MANOVA for the VIQ scores indicated a significant effect of Diagnosis, Wilks' $F(1,13) = 18.80$, $p < .001$; of Occasion, Wilks' $F(2,12) = 7.39$, $p < .008$; and a Diagnosis x Occasion interaction, Wilks' $F(2,12) = 8.53$, $p < .005$. The follow-up ANOVA on the VIQ subscale, with a Bonferroni corrected level of significance set at .01, indicated a significant effect for the Occasion, $F(1,13) = 9.71$,

$p < .008$, $MSe = 3.32$; and the Diagnosis x Occasion interaction, $F(1,13) = 18.05$, $p < .001$, $MSe = 3.32$. The interaction was attributable to an increase in the VIQ scores of the healthy participants between Occasion 1 ($M = 26.60$, $SD = 3.41$) and Occasion 5 ($M = 27.40$, $SD = 4.58$), while the scores of the AD group declined from Occasion 1 ($M = 20.80$, $SD = 2.39$) to Occasion 5 ($M = 15.60$, $SD = 3.72$).

The MANOVA for the PIQ subscale showed a main effect for Diagnosis, Wilks' $F(1,12) = 5.62$, $p < .04$. The effect of Occasion was not significant, Wilks' $F(2,11) = .57$, $p > .01$; nor was the Diagnosis x Occasion interaction, Wilks' $F(2,11) = .57$, $p > .01$. The healthy subjects scored higher ($M = 24.17$, $SD = 6.50$) than the AD subjects ($M = 16.17$, $SD = 3.22$) throughout the study.

It was hypothesized that the AD group would show declines on the VIQ and the PIQ subscales across the two years of the study. The trends of the VIQ and the PIQ scoring patterns for AD participants from Subsample 4 (including only those diagnosed with AD on Occasion 1 and present for the three occasions of assessment) were analyzed, comparing Occasions 1 and 5, with nonparametric Wilcoxon Matched-Pairs Signed-Ranks tests. The analyses indicated that the VIQ scores of AD participants ($n = 6$) declined over the two years from Occasion 1 ($M = 20.00$, $SD = 2.90$) to Occasion 5 ($M = 14.33$, $SD = 4.55$) $Z = -2.20$,

$p < .03$). In contrast, the PIQ scores did not differ significantly ($M = 14.17$, $SD = 5.23$ and $M = 12.83$, $SD = 5.81$, for Occasions 1 and 5 respectively). These findings confirm the between-subjects repeated measures MANOVA discussed earlier, although they are contrary to expectations.

The literature suggests that changes in the PIQ and VIQ scores occur at different rates in the normal aging process. To examine this trend, PIQ/VIQ ratios were calculated for the healthy and AD participants from Subsample 4. A 2 x 3 (Diagnosis x Occasion) MANOVA, with repeated measures on the last factor and ratio scores as the dependent variable was conducted. The effect of Diagnosis and the effect of Occasion were not significant, but a significant effect for the Diagnosis x Occasion interaction was obtained, Wilks' $F(2,43) = 7.28$, $p < .002$. The follow-up ANOVA showed a significant interaction, $F(1,44) = 12.99$, $p < .001$, $MSe = .02$, with the Bonferroni correction established at .025. As shown in Table 12 and Figure 3, the mean difference between the ratios for healthy and AD participants was significant at Occasion 5. As the ratio for the healthy group became smaller the ratio for the AD group increased. An inspection of the VIQ and PIQ means in Table 11 shows that the decline of the healthy group was due to an increase in the mean difference between the VIQ and the PIQ scores. The increased ratio of the AD group is due

to the decline of the VIQ scores, reducing the difference between the VIQ and the PIQ scores of the AD sample.

Insert Table 12 and Figure 3 about here

Diagnostic classification by WAIS-R subtests. To determine the best linear combination of WAIS-R subtest scores for the correct classification of study participants by diagnosis, a discriminate function analysis was conducted. A step-wise variable selection method was used with the prior probabilities of classification set at .83 for classification as healthy and .17 for classification as AD. The results showed that the combined subtests of Information, Similarities, Digit Span, Picture Completion and Blocks correctly classified 88.35% of the cases, with 3.5% false positives for the healthy group, and 50.0% for the AD.

MMSE. To evaluate the hypothesis that the healthy participants would score higher than the AD group on the MMSE at Occasion 1, a one-way analysis of variance (ANOVA) was done, with diagnosis (2) as the independent variable. The data from Subsample 2 were used in this analysis with the healthy group defined as those who were never diagnosed as AD, and the AD group composed of the subjects who were diagnosed as AD at any time throughout the study. The ANOVA indicated a significant effect for Diagnosis,

$F(1,104) = 92.54$, $p < .001$. The healthy participants scored higher on the MMSE at Occasion 1 ($M = 28.36$, $SD = 1.75$) than the AD participants ($M = 23.57$, $SD = 2.98$).

It was expected that the MMSE scores of the healthy participants would remain stable over the first two occasions of the study, while the scores of the AD group would decline. The effect of diagnosis on the MMSE scores of Subsample 3 (healthy participants who were never diagnosed with AD and AD participants who were diagnosed throughout the study, on two occasions) over six months was examined with a 2 x 2 (Diagnosis x Occasion) MANOVA, with repeated measures on the last factor and MMSE scores as the dependent variable. The MANOVA showed a significant effect for Diagnosis, Wilks' $F(1,86) = 75.95$, $p < .001$; but did not indicate a significant within-subjects Occasion effect, Wilks' $F(1,86) = .87$, $p > .05$; or the Diagnosis x Occasion interaction, Wilks' $F(1,86) = .01$, $p > .05$. The effect of Diagnosis was due to healthy participants scoring higher ($M = 28.34$, $SD = 1.89$) than the AD participants ($M = 23.55$, $SD = 3.49$).

To examine the trend of the MMSE scores across the two years of the study for the healthy participants in Subsample 4 (present on five occasions and never diagnosed with AD), a one-way, five-occasion repeated measures MANOVA, with MMSE scores as the dependent variable was done. The MANOVA did not indicate a significant effect for Occasion, Wilks'

$F(4,44) = .06$, $p > .05$. As expected, the scores of the healthy participants did not vary significantly over the five occasions of the study.

Group Differences in Reported Compensation Strategies

Analysis were conducted to investigate the hypothesis that healthy participants would use memory strategies more than AD participants. The effect of diagnosis on the CQ at Occasion 1 for Subsample 2 (the healthy group were never diagnosed with AD, and the AD group was a pooled sample of those who were diagnosed throughout the study) was investigated with a MANOVA using Diagnosis (healthy and AD) as the between-subjects variable and with subscale scores from the CQ as the dependent variables. The MANOVA indicated a significant effect for Diagnosis, Wilks' $F(7,90) = 2.47$, $p < .03$. Follow-up ANOVAs were unable to determine a significant differences at the Bonferroni corrected level of .007, between the means of the healthy and AD group on any of the scales. The greatest difference between the means of the two groups was found with the External subscale, with the healthy group ($M = 3.95$, $SD = .70$) scoring higher than the AD group ($M = 3.43$, $SD = .89$) for the AD group, although as stated this difference was not significant, $F(1,96) = 6.88$, $p = .01$.

To examine differences in the use of compensation strategies over six months (two occasions) in Subsample 3 (present over two occasions with the healthy group defined

as never diagnosed with AD, and the AD group as a pooled sample of those who were diagnosed throughout the study), seven separate 2 x 2 (Diagnosis x Occasion) ANOVAs, with repeated measures on the last variable were done, with one CQ subscale as the dependent variable in each analysis. For the purpose of comparison the means for each subscale on each of the two occasions are shown in Table 13. The repeated measures ANOVAs showed a significant effect for Diagnosis with the External subscale, Wilks' $F(1,81) = 7.36$, $p < .009$; but the within-subjects effect for Occasion was not significant, Wilks' $F(1,81) = .25$, $p > .05$, nor was the Diagnosis x Occasion interaction, Wilks' $F(1,81) = 1.05$, $p > .05$. As shown in Table 13, healthy participants reported greater use of external memory aids (e.g., lists and notes) over the two occasions.

Insert Table 13 about here

The repeated measures ANOVA for the Internal scale did not indicate significant effects for Diagnosis, Wilks' $F(1,81) = .54$, $p > .05$; nor the within-subjects effect of Occasion, Wilks' $F(1,81) = .09$, $p > .05$; nor the Diagnosis x Occasion interaction, Wilks' $F(1,81) = .02$, $p > .05$. Healthy and AD participants reported similar use of internal memory aids (e.g., "memory tricks") over the two occasions.

The repeated measures ANOVA investigating the effects of Diagnosis on the Investment of Time did not find a significant effect for Diagnosis, Wilks' $F(1,78) = .66$, $p > .05$; for the within-subjects effect for Occasion, Wilks' $F(1,78) = 1.11$, $p > .05$; nor the Diagnosis x Occasion interaction, Wilks' $F(1,78) = .57$, $p > .05$. The healthy and AD participants invested relatively the same amount of time in memory strategies over the six months.

The 2 x 2 (Diagnosis x Occasion) repeated measures ANOVA for the CQ scale measuring Reliance on Others over the two occasions did not show a significant effect for Diagnosis, Wilks' $F(1,79) = 2.33$, $p > .05$; the within-subjects effect of Occasion was not significant, Wilks' $F(1,79) = .87$, $p > .05$; but a significant effect was shown for the Diagnosis x Occasion interaction, Wilks' $F(1,79) = 5.82$, $p < .02$. As shown in Table 13, the mean difference between the scores of healthy and AD participants was greater on Occasion 2 than Occasion 1, as AD participants reported more reliance on others to help them remember, while the healthy participants reported less use of this memory strategy.

The repeated measures ANOVA assessing the effect of diagnosis on the Effort subscale over the six months did not show a significant effect of Diagnosis, Wilks' $F(1,81) = .19$, $p > .05$; nor a significant effect for Occasion, Wilks' $F(1,81) = .54$, $p > .05$; nor the Diagnosis x

Occasion interaction, Wilks' $F(1,81) = .53$, $p > .05$. Healthy and AD subjects reportedly expended similar amounts of effort in memory recall over the six months.

The repeated measures ANOVA investigating the effect of diagnosis on the Criteria for Success in remembering over six months did not show a significant effect for Diagnosis, Wilks' $F(1,81) = 1.04$, $p > .05$; nor for the effect of Occasion, Wilks' $F(1,81) = .10$, $p > .05$; or the Diagnosis x Occasion interaction, Wilks' $F(1,81) = .16$, $p > .05$. Healthy and AD participants reported similar criteria for remembering across the six months.

The repeated measures ANOVA to investigate the combined use of memory strategies (the total CQ score excluding the Change subscale) did not show a significant effect for Diagnosis, Wilks' $F(1,81) = .23$, $p > .05$; nor for the within-subjects effect of Occasion, Wilks' $F(1,81) = .25$, $p > .05$; nor the Diagnosis x Occasion interaction, Wilks' $F(1,81) = .41$, $p > .05$. Healthy and AD participants reported similar use of compensation strategies over the two occasions.

To investigate the hypothesis that the use of compensation strategies by healthy adults would increase over the two year course of the study a one-way, five-occasion repeated measures MANOVA was conducted with each of the CQ scales as dependent variables, for the healthy participants from Subsample 4 (present on over the two years

and never diagnosed as healthy). The MANOVA for the External subscale did not show a significant effect of Occasion, Wilks' $F(4,31) = .32$, $p > .05$. Contrary to expectations, the healthy participants' mean level of External strategy use did not change significantly over the five occasions.

The MANOVA for the Internal subscale did not indicate a significant effect for Occasion, Wilks' $F(4,30) = 2.29$, $p > .05$. Healthy subjects mean use of Internal memory strategies did not vary significantly across the two years of the study.

The MANOVA for the Investment of Time subscale did not show a significant effect for Occasion, Wilks' $F(4,30) = 1.80$, $p > .05$. The amount of time healthy subjects invested in memory strategies did not change significantly across the 5 occasions of the study.

The Reliance on Others MANOVA indicated a significant effect for Occasion, Wilks' $F(4,31) = 5.21$, $p < .003$. The ANOVA, with a Bonferroni corrected level of significance set at .01, showed that the mean score for Occasion 2 was significantly lower than the mean score of Occasions 1 and 5, $F(1,34) = 12.05$, $p < .002$, $MSe = .22$. Further follow-up analyses were conducted to determine the significance of the differences in reported use of the Reliance on Others strategy between specific occasions. The Bonferroni

corrected level of significance was established at .01. The difference between the scores of Occasion 2 (*M* = 1.40, *SD* = .65) and Occasion 4 (*M* = 1.87, *SD* = .71) was tested with a two-occasion, within subjects repeated measures MANOVA. This comparison showed a significant effect for Occasion, Wilks' *F*(1,34) = 20.81, *p* < .001. A similar repeated measures MANOVA, conducted with the scores from Occasion 2 and Occasion 3 (*M* = 1.86, *SD* = .76) also showed a significant effect for Occasion, Wilks' *F*(1,34) = 13.25, *p* < .002. A repeated measures MANOVA assessing the difference between the scores of Occasion 2 and Occasion 5 (*M* = 1.75, *SD* = .62) showed a significant effect for Occasion, Wilks' *F*(1,34) = 11.63, *p* < .003. A similar repeated measures MANOVA testing the differences between Occasion 2 and Occasion 1 (*M* = 1.73, *SD* = .65) also showed a significant effect for Occasion, Wilks' *F*(1,34) = 8.29, *p* < .008. As shown in Table 14, healthy subjects reported significantly less use the Reliance on Others strategy on Occasion 2 than on the other occasions of assessment. A two-occasion, within subjects repeated measures MANOVA was also conducted to determine the significance of the difference in the scores between Occasion 1 and Occasion 4. The MANOVA did not show a significant effect for Occasion, *F*(1,34) = 1.49, *p* > .01. These analyses showed that the higher order effects of Occasion found in the omnibus MANOVA

for the Reliance on Others subscale were due to the significantly lower scores on Occasion 2.

Insert Table 14 about here

The repeated measures MANOVA examining changes over time in the reported use of tasks related to the Effort subscale indicated a significant effect for Occasion, Wilks' $F(4,31) = 3.12$, $p < .03$. The follow-up ANOVAs did not indicate a significant difference between the occasions to account for this effect, at a Bonferroni corrected level of significance of .01. Indeed, an ANOVA indicated that the mean score of healthy participants was higher on Occasion 4 ($M = 2.88$, $SD = .88$) than the average of the other four occasions ($M = 2.69$, $SD = .85$), $F(1,34) = 4.50$, $p < .05$, $MSe = .24$. An inspection of the means in Table 14 indicated that the reported effort expended to remember increased between Occasion 1 and Occasion 4, dropping on Occasion 5, although these differences are not significant.

The MANOVA investigating the effect for Occasion on the Criteria for Success subscale did not show a significant effect, Wilks' $F(4,29) = .76$, $p > .05$. The criteria for success of healthy participants did not differ across the two years of the study.

A MANOVA assessing the effects of Occasion on the total CQ scale, excluding the Change scale, indicated a significant effect for Occasion, Wilks' $F(4,31) = 5.08$, $p < .004$. The ANOVAs, with a Bonferroni corrected level set at .01, showed that the mean response to the total CQ was significantly higher on Occasion 4 ($M = 2.87$, $SD = .60$) than the averaged scores of the remaining occasions ($M = 2.75$, $SD = .59$), $F(1,34) = 6.88$, $p < .01$, $MSe = 06$.

Follow-up analyses were conducted to determine the significance of mean differences in the reported strategy use for specific occasions. The Bonferroni corrected level of significance was set at .025. A two-occasion, within-subjects repeated measures MANOVA was conducted with the mean scores of Occasion 2 and Occasion 4. The MANOVA indicated a significant effect of Occasion, Wilks' $F(1,34) = 14.33$, $p < .001$. A similar MANOVA was conducted with the scores from Occasion 2 and Occasion 3, resulting in a nonsignificant effect for Occasion, Wilks' $F(1,34) = 5.33$, $p > .025$. The means in Table 14 indicate that the scores of the healthy participants showed a nonsignificant decline on Occasion 2, then increased significantly to Occasion 4.

To investigate the significance of differences in the reported use of External and Internal memory strategies over two occasions, a 2 x 2 x 2 (Diagnosis x Strategy Type x Occasion) MANOVA was conducted, with repeated measures on the last two factors and the External and Internal Measures

as the dependent variables. The data from Subsample 3 were used in this analysis, with the healthy group defined as those who were never diagnosed with AD, and the AD group composed of a pooled sample of those who were diagnosed at any time throughout the study. All participants were present on two occasions. The MANOVA indicated that the effect for Diagnosis was significant, Wilks' $F(1,81) = 4.18$, $p < .05$; as was the main effect for Strategy Type, Wilks' $F(1,81) = 144.51$, $p < .001$; but the main effect for Occasion was not significant, Wilks' $F(1,81) = .24$, $p > .05$. The Diagnosis x Occasion interaction effect was not significant, Wilks' $F(1,81) = .24$, $p > .05$; nor was the interaction of Diagnosis x Strategy Type, Wilks' $F(1,81) = 2.94$, $p > .05$; nor the Diagnosis x Occasion x Strategy Type interaction, Wilks' $F(1,81) = .55$, $p > .05$. As shown in Table 13, healthy participants ($M = 3.21$, $SD = .70$) reported greater use of Internal and External strategies over the six month interval than the AD participants ($M = 2.96$, $SD = .76$), and both groups relied on External strategies ($M = 3.71$, $SD = .75$) to a greater degree than Internal aids ($M = 2.46$, $SD = .71$).

To examine differences in the use of External and Internal strategies over the five occasions, a 2 x 5 (Strategy Type x Occasion) MANOVA, with repeated measures on both factors was carried out with the healthy participants from Subsample 4 (healthy and present over the two years of

the study). The multivariate analysis showed the effects of Strategy Type were significant, Wilks' $F(5,29) = 35.31$, $p < .001$. The ANOVAs indicated a significant effect for Strategy Type on each of the five occasions with a Bonferroni corrected level of significance set at .01. As shown in Table 14, the pattern over the two years of the study reflects the results of the first two occasions, with healthy participants reporting greater use of External memory aids ($M = 3.90$, $SD = .73$) than Internal ($M = 2.55$, $SD = .75$), Occasion 1 $F(1,33) = 141.06$, $p < .001$, $MSe = .24$; Occasion 2 $F(1,33) = 144.38$, $p < .001$, $MSe = .27$; Occasion 3 $F(1,33) = 112.65$, $p < .001$, $MSe = .23$; Occasion 4 $F(1,33) = 84.90$, $p < .001$, $MSe = .35$; Occasion 5 $F(1,33) = 78.75$, $p < .001$, $MSe = .35$.

A 3 x 5 (Strategy Type x Occasion) MANOVA with repeated measures on the last factor was conducted with Investment of Time, Effort, and Reliance on Others as the levels of Strategy Type to compare the reported use of these subscales. The MANOVA indicated that the effect of Strategy Type was significant, Wilks' $F(2,32) = 60.20$, $p < .001$; as was the effect of Occasion, Wilks' $F(4,30) = 7.69$, $p < .001$. The Occasion x Strategy Type interaction was not significant, $F(8,26) = 1.22$, $p > .05$. With the Strategy Type the ANOVAs showed a significant effect,

$F(1,33) = 119.31$, $p < .001$, $MSe = .87$, with a Bonferroni corrected level of significance set at .025. The combined strategies of Investment of Time and Effort ($M = 2.68$, $SD = .84$) were reportedly used significantly more than the strategy of Reliance on Others ($M = 1.73$, $SD = .66$).

Awareness of Deficits

The hypothesis that lower intelligence scores would be related to reduced insight was investigated in these analyses. To examine the relationship between the awareness of memory function and general intelligence, three sets of correlations between MMSE scores and (a) the CQ subscale of Change, as a self-reported assessment of changing memory capacity, (b) the total CQ (excluding Change), and (c) the Awareness of Deficits item from the CPRS, were carried out for each of the five occasions of measurement with scores from Subsample 5 (healthy participants were never diagnosed with AD, and the AD participants were included in the analyses on the occasion of diagnosis). The correlations showed that the relationship between the MMSE scores and the CQ measures of awareness of memory function were of a very small magnitude (ranging from $r = .003$ to $-.13$), thus were not significant at the Bonferroni corrected alpha level of $p < .003$. In contrast, as shown in Table 15, the MMSE showed a moderate relationship to the CPRS Awareness of Deficit score, significant at $p < .001$ with higher levels of intelligence related to nonimpaired levels of awareness.

Insert Table 15 about here

Bleecker, Bolla-Wilson, Kawas, and Agnew (1988) established an age-specific cut-off score for the MMSE of 26 or better for normal functioning adults between the ages of 80-89. It was expected that cognitively impaired participants (MMSE < 26) would have lower levels of deficit awareness than the normal functioning participants (MMSE 26 or above). The scores from Subsample 2 on Occasion 1 were standardized using Z scores for the CQ total and the CPRS awareness measures in this analysis. To examine the effects of Cognitive Group (normal and impaired) and Awareness Type a 2 x 2 MANOVA conducted. The analysis indicated a significant effect for Cognitive Group, Wilks' $F(1,101) = 29.90$, $p < .001$. As expected, the impaired subjects scored significantly lower on both the CQ total (Mean $Z = -.67$, $SD = .72$) and the CPRS awareness measure (Mean $Z = -.91$, $SD = 1.78$) than the normal subjects (CQ total Mean $Z = .12$, $SD = .99$; CPRS Mean $Z = .21$, $SD = .56$, respectively). This pattern of results suggests that the impaired group indicated less awareness of cognitive deficit than the normal group. The effect of Awareness Type was not significant, Wilks' $F(1,101) = .23$, $p > .05$, nor was the Cognitive Group x Awareness Type interaction, Wilks' $F(1,101) = 1.02$, $p > .05$.

To assess changes in awareness of cognitive deficits and intelligence over time, a 2 x 2 (Group x Occasion) MANOVA, with repeated measures on the last variable, and the total CQ and the CPRS awareness measure as the dependent variables, was done. The subjects were from Subsample 3 and were divided into normal (MMSE score of greater or equal to 26) and impaired (MMSE score of less than 26) and Z scores were used to standardize the metric. The MANOVA showed a significant effect for Group, Wilks' $F(2,57) = 16.77$, $p < .001$. The effect for Occasion was not significant, Wilks' $F(2,57) = 2.18$, $p > .05$. The Group x Occasion interaction effect was not significant, Wilks' $F(2,57) = 2.93$ $p > .05$. Contrary to expectations, the levels of memory awareness did not vary significantly across the six months of assessment, although the normal participants were significantly more aware (Mean $Z = .17$, $SD = .73$) than the impaired participants (Mean $Z = -.89$, $SD = 1.25$).

Group Differences in the CPRS Depression Scale

The analyses in this section were conducted to determine the effects of depression on the intelligence test performance of healthy and AD elderly adults. To examine the effect of diagnosis on the DSM-based depression scores of Subsample 2 at Occasion 1, a one-way ANOVA with Diagnosis (2) as the independent variable and depression score as the dependent measure, was done. The ANOVA did not indicate a

significant effect for Diagnosis, $F(1,102) = 1.54$, $p > .05$. The healthy participants ($M = .16$, $SD = .17$) had a level of depression similar to the AD participants ($M = .22$, $SD = .20$).

To assess the impact of diagnosis across two occasions of CPRS measurement, a 2 x 2 (Diagnosis x Occasion) MANOVA with repeated measures on the last variable and the DSM-based depression measure as the dependent variable, was done with Subsample 3. The results did not indicate a significant effect for Diagnosis, Wilks' $F(1,64) = 1.98$, $p > .05$; nor for the effect of Occasion, Wilks' $F(1,64) = 2.97$, $p > .05$. The Diagnosis x Occasion interaction was not significant, Wilks' $F(1,64) = .74$, $p > .05$. The depression scores did not vary significantly between the healthy and demented groups across the six months of assessment.

A one-way, five-occasion repeated measures MANOVA was conducted to investigate changes in the DSM-based depression scores in the healthy subjects of Subsample 4. The results indicated a significant effect for Occasion, Wilks' $F(4,28) = 8.34$, $p < .001$. The follow-up ANOVAs, with the Bonferroni correction for significance set at .01, showed a significant difference in depression scores across the two years of the study, $F(1,31) = 8.76$, $p < .007$, $MSe = .05$, with healthy subjects presenting more depressive symptoms on Occasion 5 ($M = .26$, $SD = .33$) than Occasion 1 ($M = .10$,

SD = .11).

The CPRS DSM-based depression measure is composed of two subscales; one measuring the observed signs of depression, such as expressions of sadness, while the other measures self-reported symptoms of depression, such as the lack of interest in usual activities. To assess the differences between self-reported and observed measures of depression on the CPRS scale as a function of diagnosis, a 2 x 2 (Diagnosis x Rating Type) MANOVA with repeated measures on the last factor was conducted, with Occasion 1 scores from Subsample 2. The MANOVA did not show a significant effect of Diagnosis, $F(1,102) = 2.36$, $p > .05$. A significant effect for Rating Type was found, $F(1,102) = 4.15$, $p < .05$, but the Diagnosis x Rating Type interaction was not significant, $F(1,102) = 3.01$, $p > .05$. The follow-up ANOVA on the Observed Rating Type, with a Bonferroni corrected level of significance set at .025, indicated a significant effect of Diagnosis, $F(1,102) = 6.24$, $p < .015$, $MSe = .05$. The healthy participants had a lower observed level of depression, $M = .06$, $SD = .19$, than the AD subjects, $M = .21$, $SD = .37$.

To examine changes in the effects of diagnosis on the reported or observed measures of depression across time, a 2 x 2 x 2 (Diagnosis x Rating Type x Occasion) MANOVA was done, with repeated measures on the last two factors and DSM-based Reported and Observed depression scores for

Subsample 3 as the dependent variables. The MANOVA did not show a significant main effect for Diagnosis, Wilks' $F(1,64) = 2.54$, $p > .05$; nor for the within-subjects effect of Occasion, Wilks' $F(1,64) = 1.56$, $p > .05$, nor Rating Type, Wilks' $F(1,64) = 3.44$, $p > .05$. The Diagnosis x Occasion interaction was not significant, Wilks' $F(1,64) = 2.00$, $p > .05$; nor were the effects of the Diagnosis x Rating Type interaction, Wilks' $F(1,64) = .67$, $p > .05$; nor Rating Type x Occasion interaction, Wilks' $F(1,64) = .02$, $p > .05$; nor the Diagnosis x Rating Type x Occasion interaction, Wilks' $F(1,64) = 1.72$, $p > .05$. Across two occasions the effects of diagnosis did not influence the ratings of observed or reported depressive symptoms in the healthy and AD groups.

Depression and intelligence. A block-wise multiple regression analysis with the VIQ scores of Subsample 2, Occasion 1 as the dependent variable was done to investigate the impact of diagnosis and depression level on verbal intelligence. The effect of Age, as the independent variable in the first block, did not account for a significant amount of variance, $F(1,100) = .33$, $p > .05$ with an $R^2 < .01$; Beta = -.06 for a $t = -.58$, $p > .05$. The Diagnosis and Depression scores were entered as the independent variables in the second block. The regression showed a significant combined effect for Diagnosis and Depression, $F(3,98) = 9.54$, $p < .001$, with an R^2 of .23.

Depression scores accounted for little of the variance with Beta = -.11, t = -1.23, p > .05. The effect for Diagnosis was significant with Beta = -.44, t = -4.89, p < .001. The R^2 change following the second block was .22, indicating that together Diagnosis and Depression scores accounted for 22% of the variance in VIQ scores with the effects of Age controlled.

A similar block-wise multiple regression analysis was conducted to determine the effects of diagnosis and depression on the PIQ measure of the WAIS-R. Age, entered as the first independent variable, did not account for a significant amount of variance, $F(1,99)$ = .80, p > .05, with an R^2 of less than .01; Beta = -.09, t = -.89, p > .05. The second block of independent variables, Diagnosis and Depression, accounted for a significant amount of variance in the PIQ scores, $F(3,97)$ = 12.21, p < .05, with an R^2 of .27. The Beta for Diagnosis was -.44, t = -5.07, p < .05. Depression accounted for less of the variance, with Beta = -.20, t = 2.25, p < .03. The R^2 change following the second block indicated that Diagnosis and Depression account for 27% of the variance, controlling for the effects of Age.

A block-wise multiple regression analysis on the MMSE scores, with Age as the independent variable in the first block and Diagnosis and Depression in the second, revealed that the effect of Age was not significant, $F(1,102)$ = .002, p > .05, with an R^2 of < .01. The Beta for Age was < .01,

t = -.05, p > .05. The effect of Diagnosis and Depression on MMSE scores was significant, $F(3,100) = 35.13$, $p < .001$, with an R^2 of .51. The Beta of Diagnosis was -.66, t = -9.37, $p < .001$. Depression scores accounted for less of the variance, with a Beta of -.21, t = -3.01, $p < .004$. The R^2 change following the entry of the second block was .51, indicating that with the effects of age controlled, Diagnosis and Depression accounted for 51% of the variance in MMSE scores.

Depression and awareness. The literature suggests that depressed people are more aware of cognitive deficits than non-depressed (Niederehe, 1986), although this relationship is less reliable in AD subjects (Burns, 1990). To examine the relationship between depressive symptoms and awareness a series of correlations across five occasions were conducted for Subsample 5 (healthy subjects were never diagnosed as AD, and the AD participants were included on the occasion of diagnosis). These correlations were between the CPRS DSM-based depression measure and (a) the CQ total (excluding change), and (b) the CPRS Awareness measure. The correlations did not indicate a significant relationship between the CQ total and the CPRS depression measure (range: r = -.02 Occasion 1, to r = .18 Occasion 3), at a Bonferroni corrected alpha of .005. At the Bonferroni corrected alpha level the correlation between the CPRS awareness measure and the depression scores only showed a significant relationship

on Occasion 1, r = .44, p < .001, however the magnitude of the relationship at Occasion 2 was similar, r = .35, p > .005. Contrary to expectations, higher levels of depression were related to higher levels of awareness pathology. In other words, as the participants showed less awareness of their deficits they had higher levels of depression.

Attrition

The participants in this study were all between the ages of 77 and 87 years of age at the initial assessment. Although they were found to be in sound physical health at that time, selective attrition over the course of the study is of potential concern. To determine whether those who remained in the study differed from those who were no longer participants at Occasion 5, a series of MANOVAs were conducted. First, to examine possible differences on the demographic variables of age and education a one-way MANOVA on Occasion 1 data was conducted. There were two levels of the group factor, those present at Occasion 5 (n = 76) and those not present (n = 30) on that Occasion. The MANOVA indicated a significant Group effect, Wilks' $F(2,103) = 3.11$, $p < .05$. The follow-up ANOVA, with a Bonferroni corrected level of significance set at .025, indicated a marginally significant Group effect for Age, $F(1,104) = 5.26$, $p > .025$, $MSe = 9.01$. The subjects who

remained in the study were younger (M = 81.38, SD = 3.06) than those who dropped out at Occasion 5 (M = 82.87, SD = 2.86). The Group effect for education was not significant, $F(1,104) = .97$, $p > .025$. Those remaining in the study were similar in education level to those who withdrew.

A MANOVA was conducted to examine the differences between the two groups, those remaining in the study on Occasion 5 (n = 73) and those who were not measured on Occasion 5 (n = 29) on VIQ, PIQ and MMSE scores of healthy and AD participants at Occasion 1. The MANOVA did not show a significant Group effect, Wilks' $F(3,98) = .33$, $p > .05$. The subjects remaining in the study did not differ significantly on measures of intelligence from those who had left the study by Occasion 5.

To investigate possible differences between the two groups, those remaining in the study on Occasion 5 (n = 73) and those who withdrew by Occasion 5 (n = 29), in the scores on the CQ total and CPRS awareness measure on Occasion 1, a MANOVA was conducted. The MANOVA did not indicate a significant effect for Group, Wilks' $F(2,99) = .46$, $p > .05$. Participants remaining in the study at Occasion 5 did not differ from those discontinuing on measures of compensation or awareness of deficit.

A one-way ANOVA with two levels of Attrition and the CPRS DSM-based depression subscale as the dependent variable

was conducted with the scores from Occasion 1, to assess group differences in depression. The ANOVA did not show an effect for depression, $F(1,103) = 2.87$, $p > .05$. The subjects remaining in the study on Occasion 5 did not differ significantly on this measure of depression from those discontinuing.

Chapter V

Discussion

This study was designed to increase the general understanding of the cognitive abilities of very old adults, and how these abilities relate to the use of compensatory memory strategies, to the awareness of memory functioning, and to depressive affect. The sample included two groups of adults, one group diagnosed as healthy and the other with a probable diagnosis of Alzheimer's disease. The participants were all over the age of 77 years, and were measured at six month intervals over a two year period, yielding five occasions of measurement.

Psychometric Results

As there is little research on the psychometric reliability of research tools for the assessment of very old adults, it was necessary to establish the reliability of the MMSE, the WAIS-R subscales, the CQ and the CPRS in this sample, before the research questions could be addressed.

While a body of research is beginning to emerge investigating the performance of elderly adults on the WAIS-R, little research has examined the internal consistency of the WAIS-R subscales in this population. The internal consistency of each of the abbreviated WAIS-R subscales, the VIQ and the PIQ, in this sample were moderate for both the healthy and the demented subjects. This indicates that the subtests comprising each of these

subscales measures a similar aspect of intelligence. Factor analytic studies of the WAIS-R with older adults, identifying the VIQ and the PIQ as primary factors supports these findings (Ryan et al., 1990b; Smith et al., 1992).

The test-retest reliability of the VIQ and the PIQ was assessed to measure the stability of the psychometric properties of each of the subscales in this sample. The results indicated that the two year test-retest coefficients of the abbreviated VIQ and the PIQ subscales were acceptable. The retest coefficients in this sample are comparable to those reported by Snow and his colleagues (1989) for the complete subscales over a one year period, although they are somewhat lower than the split-half coefficients reported by Ryan and colleague (1990a). This would suggest that although intraindividual differences in intraindividual change across time decreases the consistency of the VIQ and the PIQ measures, these subscales provide a psychometrically reliable measure of intelligence across the two year time span of this study.

The MMSE is generally regarded as a reliable measure of intelligence, suitable for screening elderly adults for dementing illnesses (Folstein et al., 1975), although there is some question about the stability of the psychometric properties of the scale when it is administered repeatedly over an extended period of time to healthy adults (Olin & Zelinski, 1991). While Olin and Zelinski (1991) reported a

low (r = .23) test-retest reliability in a healthy sample over a period of one year, the current study suggests that the MMSE provides a reasonably reliable measure for the healthy sample over a two year period (r = .66).

The reliability of the MMSE scores in this sample is reflected in a moderately sized six month test-retest coefficient for the AD participants (r = .54) and the healthy participants (r = .79). While the results did not indicate the degree of reliability (r = .99) reported by Folstein and his colleagues (1975), the extended time between the original test and the retest in the current study required subjects to accurately orient to changing seasons, a factor that Olin and Zelinski (1991) have identified as a likely source of variability.

The seven subscales of the CQ each showed generally acceptable levels of internal consistency for the healthy and AD sample in this study. The test-retest reliability of each of the subscales over a two year period for the healthy sample indicated that the subscales are reliable measures. As would be expected, the healthy participants' report of memory performance over the last five to ten years in the Change subscale is less reliable than the subscales measuring memory strategies currently in use.

The CPRS DSM-based depression scale showed an acceptable level of internal consistency for the healthy adults, although the scale was not as cohesive with the AD

sample, possibly due to difficulties in applying diagnostic criteria. The diagnosis of depression in an elderly sample is often difficult, as the changes associated with depression in younger adults may be viewed by the examiner or the subject as a normal part of the aging process (Cohen, 1990). When the aging process is complicated by AD the identification of depressive symptoms becomes even more difficult for both parties.

The test-retest correlations of the CPRS showed a high level of psychometric reliability for the healthy sample across the two years of the study, although the six month retest reliability for the AD sample was low. The results of this study suggest that the CPRS DSM-based depression scale may be an reliable measure of depressive symptoms in very old healthy adults, but caution must be exercised when interpreting the results with those diagnosed with AD.

Group Differences in Intelligence

Once the psychometric properties of the assessment tools were established the first empirical question to be investigated was the differences in the performance of healthy and AD participants on measures of intelligence. The hypothesis that healthy participants would score higher than the AD participants on the PIQ and the VIQ subscales of the WAIS-R and the MMSE was supported in the analyses. Typically, memory deficits are the first cognitive decrements associated with the early stages of AD (Hill et

al., 1992; Joynt et al, 1985). Although the WAIS-R subscales are not considered to be measures of memory, healthy adults in this study scored higher on the VIQ and the PIQ subscales than those with AD on the assessment following diagnosis. This finding suggests that shortened versions of the VIQ and PIQ subscales are sensitive to the reduction of general reasoning abilities in the early stages of AD.

The difference between the scores of the healthy and AD groups on both the VIQ and the PIQ was maintained across the two years of the study at a significant level. These results were supported in analyses comparing the AD group to the entire sample of healthy participants over three occasions, as well as in analyses over three occasions with a matched group of healthy participants. Despite the small number of AD participants available for the three occasions of assessment, this appears to be a reliable finding.

The independent examination of the VIQ scores of the healthy participants showed that cognitive abilities remained stable over the two year course of the study. While this finding was predicted in the hypothesis for the VIQ scores, the PIQ scores were expected to show a systematic decline. Although there was a significant drop in PIQ scores between Occasion 3 and Occasion 5, the magnitude of the decline was very small and the scores on Occasion 5 were not significantly different from those of

the initial assessment. Wechsler (1981) reported that the PIQ subscale shows greater learning effects than the VIQ subscale in a younger sample, as the novelty of the tasks is reduced with repeated presentation. In the current study repeated exposure to the novel tasks of the PIQ subscales may have facilitated learning, possibly compensating for the predicted declines, despite the one year period between test occasions.

Healthy participants. The literature based on cross-sectional designs predicted that the scores of the healthy participants would show decline over the two years of the study (Ryan et al, 1990b). The finding of nonsignificant change in the healthy sample for the VIQ subscale and the MMSE are similar to the results of other longitudinal studies (Botwinick et al., 1986). Botwinick and his colleagues (1986) concluded that the stability of the cognitive abilities of very old adults over a four year period was an artifact of the selection process. Although the current study was also limited by a self-selected sample of volunteers who were diagnosed as free from serious of illness, it does not neutralize the findings of stable cognitive abilities in healthy, very old adults. Although the results cannot be generalized to include those elderly in the community who suffer from serious illness they may be an indication that a growing proportion of healthy elderly can expect to maintain abilities associated with

crystallized intelligence in advanced age, while experiencing only moderate declines in the cognitive abilities associated with fluid intelligence.

The literature on cognitive aging suggests that crystallized intellectual abilities are maintained longer than abilities associated with fluid intelligence (e.g., Schaie, 1990). These findings are generally supported by research investigating the age-associated changes in WAIS-R performance, where VIQ scores as an indicator of crystallized abilities are maintained at a higher level in old age than PIQ scores, which are thought to indicate fluid abilities (Sattler, 1982). The analyses shows that the VIQ scores of the healthy sample were higher than the PIQ scores throughout the course of the study. Participants in this study are not highly educated, therefore, it is unlikely that this finding is an artifact of education.

AD participants. In contrast to the stable VIQ scores of the healthy sample, the VIQ scores of the AD group declined over the two years of the study, as expected. A surprising result was the stability of the PIQ in this group over the course of the study. While the sample of AD subjects measured on the PIQ over the three occasions was very small this finding was significant in all analyses, including the nonparametric test to examine the trends of the AD participants, independent of the healthy sample. The early stages of AD are characterized by memory impairment,

therefore with a one year interval between retests it is unlikely that learning would have a significant compensatory effect in this case. It may be notable that the PIQ scores of the AD participants were the lowest WAIS-R scores of the entire sample at the initial assessment. This may indicate that the PIQ scores of the AD sample have reached a low plateau phase where they are likely to remain until the disease enters a more severe stage.

Changes in the PIQ/VIQ ratio were assessed to determine how these subscales varied in relation to one another throughout the study. The analysis showed opposite patterns of change between the healthy and AD samples over the two years. The ratio of the healthy sample became smaller over the course of the study as the PIQ scores declined. This supports the literature suggesting that the reasoning ability of very old adults on tasks requiring fluid intelligence declines over time, while abilities associated with crystallized abilities remain stable (Schaie, 1990). In contrast, the ratio for the AD sample increased over the two years, with declines in the VIQ scores relative to the PIQ scores. This indicates that while verbal abilities may be maintained for a longer period of time than nonverbal abilities, declines are noted early in the disease.

The relative ranking of the VIQ and the PIQ scores in the AD sample was not predicted. Based on the Fuld (1984)

profile it was expected that the VIQ scores would remain at a higher level than the PIQ scores over the two years of the study. Surprisingly, the VIQ scores declined systematically over the two years, bringing them to a lower level than the PIQ scores at the final assessment. The Digit Span task of the VIQ subscale, requiring the subjects to immediately recall a string of digits in the order of presentation in the first condition, then in reverse order in the second condition, is influenced by attention deficits and impairment of immediate memory, both problems commonly presented in the early stages of AD (Joynt et al., 1985). The Information task of the VIQ measuring subjects' cultural knowledge, draws on remote memories acquired throughout a lifetime. Scores on this task, as well as the scores from the Similarities subtest, which asks subjects to identify how two objects are alike, may be reduced by impaired abilities to understand complex language. Language dysfunction, beginning with word finding problems, has been noted early in AD, progressing to include all language functions with the increased severity of the disease (Appell, Kertesz, & Fisman, 1982). The declining VIQ scores of the AD sample who participated over the two year course of the study may be diagnostic of the increasing severity of their illness.

Diagnosis. The MMSE is a gross measure of intelligence with single items measuring various cognitive abilities,

including one item assessing short term memory capabilities. It was designed as a screening tool for dementia in the elderly population (Folstein et al., 1975), therefore it is not surprising that in this study the mean score for the healthy sample was significantly higher than the AD sample, and well above the age-corrected cut-off score established by Bleecker and his colleagues (1988). In contrast, the mean score of the AD sample was well within the impaired range, with only one AD subject scoring within the normal range. The results suggest that the MMSE is an effective screening tool for dementia.

Attempts to develop diagnostic criteria for dementia based on the WAIS-R have generally met with less success than the MMSE. The Fuld (1984) profile was developed to distinguish between various types of dementia, but research indicates that the specific combination of scores used to diagnose dementia occurs infrequently in AD samples, as well as the general population of elderly adults (Logsdon et al., 1989; Tuokko et al., 1987). As the full WAIS-R was not administered in the current study the accuracy of the Fuld profile could not be determined, but a discriminant function analysis to estimate the best combination of subtests for diagnostic classification was carried out. The results indicated that the three VIQ subtests of Information, Digit Span and Similarities, in addition to the PIQ subtests of Picture Completion and Blocks correctly classified over 88%

of the participants. Only 3.5% of the healthy group scored low enough on this combination of tests to be classified as AD, while half of the AD subjects performed well enough to be classified as healthy. This analysis was limited by the unequal proportions of the groups, allowing for a lower probability of false positives in the dementia classification. Nevertheless, the cognitive performance of 50% of the AD group, on these measures, was only mildly impaired at the first occasion of assessment following diagnosis, allowing them to be misclassified as healthy. This study has not attempted to determine a diagnostic criteria based on WAIS-R subtest scores; however, low scores on these five subtests should provide an indication that further investigation is needed to rule out the possibility of dementia in a clinical assessment.

Compensation Strategies

One of the clear results of this study was that healthy very old adults scored higher on measures of intelligence than adults of the same age who have been diagnosed with AD. Wechsler (1981) defined the aspects of intelligence measured by the WAIS-R subscales as the ability to understand and deal effectively with the requirements of the environment. This definition implies that people with higher levels of cognitive abilities are more able to monitor the demands of the environment and employ effective strategies to compensate for perceived deficits. This study investigated

the relation between cognitive abilities and compensation strategies. The expectation was that healthy older adults would report greater use of memory aids than participants who were diagnosed with AD. The results indicated that the overall strategy use of healthy adults was greater than the reported use of memory aids by the AD group, providing support for the hypothesis in general. This suggests that there may be a link between general intelligence and the ability to employ strategies to maximize the fit between environmental demands, expectations, and perceived abilities. The healthy adults were more able to identify effective means of maximizing memory performance, while those who most needed the aid of memory strategies appeared generally to be less likely to employ them spontaneously.

The CQ provides measures on six specific types of memory strategies, allowing for detailed investigation into the types of strategies preferred, and whether this varies with general levels of intelligence. Comparing the use of each of the scales between the diagnostic groups over two occasions, it was expected that the healthy group would report greater use of all strategies, with the exception of Reliance on Others, than the AD group. In addition, the reported use of strategies by the healthy group was expected to increase over time, while the use of strategies by the AD group was expected to decline. The findings show support for the hypotheses that healthy adults continued to report

greater use of compensatory memory strategies than the AD group over the six month period. However, the results did not show significant changes in strategy use by either group over this time frame. Healthy adults were expected to show practice effects on the second administration of the CQ as questioning strategy use implicitly suggests alternative memory strategies. Clearly, this expectation was premature, as a separate analysis of the two year trend for the healthy indicated that strategy use did not increase until the third administration of the CQ.

The expectation of reductions in the use of memory strategies by the AD group was based on the assumption that levels of general intelligence would decline over this time period. The results indicate that this assumption as well was faulty. As stated earlier, changes in the MMSE, the only measure of cognitive ability available for the larger group of AD subjects over the two occasions, did not indicate significant levels of intellectual decline. Thus, it is not surprising that the hypothesis that the AD group would show reduced strategy use was not supported.

Generally, healthy adults reported slightly greater use of all memory strategies than those suffering from AD, but as with other rules there are exceptions. The reported use of the CQ subscale measuring Reliance on Others showed diverging patterns of change for the AD and the healthy samples. On Occasion 1 the level of reported use of this

strategy was similar for the AD and the healthy subjects. Six months later, however, the healthy group reported declining use of this strategy, while the reported use by the AD group increased. While this result may appear to contradict the hypothesis that high levels of cognitive abilities are linked to a high utilization of compensatory strategies, the strategy of relying on others to assist memory may demand fewer intellectual resources than other strategies, thus Reliance on Others becomes a primary strategy for those with limited resources.

A surprising finding was that the AD sample reported a consistently higher criteria for successful remembering than the healthy sample. It appears that the mild cognitive decline associated with the incipient stages of AD may increase anxiety about memory performance. For example, once declining abilities are noted it then becomes very important to perform memory tasks, such as remembering a newspaper article, perfectly. The increasing importance of perfect recall indicates that AD subjects are likely aware of memory deficits, but unable to judge the severity of the dysfunction as they have established an excessively high standard for judging their memory functioning. These results offer support for the contention that awareness of deficits is the highest at this stage of disease, although even in this early phase of AD it has been shown in other studies to be impaired relative to healthy controls

(Reisberg et al., 1986).

Previous research suggests that older adults use external memory strategies, such as lists and notes, to a greater extent than internal strategies, such as imagery or other "memory tricks" (Reeves & Dobbs, 1992). The healthy participants in the current study also reported greater use of the external strategies than other memory aids consistently over the two year course. It is of interest that the AD group also reported greater use of external strategies over a six month period. While the AD group showed a pattern of strategy use that deviated from the healthy group in many respects (e.g., greater use of reliance on others and a higher criteria for success) they used external memory supports in the same manner as their healthy counterparts. Reeves and Dobbs (1992) report that older adults believe external strategies are more effective memory support than internal strategies, possibly explaining this result. In addition, the use of external strategies requires fewer cognitive resources, and may therefore be an adaptive strategy for the those with AD group early in their illness.

Comparing the use of internal memory strategies, such as expending more time and effort to recall information, with the external strategy of reliance on others, shows that the latter was the least preferred form of compensation for the healthy adults over the two years of the study. The

scores from the Reliance on Others subscale were consistently low (ranging from M = 1.40 on Occasion 2 to M = 1.87 on Occasion 3) for the healthy participants, indicating that they never (1) or seldom (2) rely on others for memory aid.

Awareness and Intelligence

The results indicate that the healthy participants employ memory strategies to compensate for the real or perceived mismatch between the demands of the environment and their own memory abilities, at least to a greater degree than do AD participants, supporting the concept of compensation adopted for this study. This suggests that the use of compensatory memory strategies requires a relatively high level of cognitive ability. The theoretical model of compensation developed by Dixon and Bäckman (in press; Bäckman & Dixon, 1992) also suggests that awareness of deficit is a necessary component of compensation. Although this study did not include an extensive on-line measure of awareness, the use of compensatory strategies implies that healthy participants were more able than the AD participants to judge the discrepancy between environmental demands and ability. As the level of cognitive decline exacerbates the mismatch between the expected and the actual performance of the AD sample, their ability to use compensation strategies and possibly their level of awareness also declines. These findings suggest that both the ability to compensate for

cognitive decline and the awareness of memory dysfunction begin to decline at a relatively early stage of AD.

In this study three measures were selected to estimate deficit awareness: (a) the total CQ based on the theoretical concept of the inherent link between awareness and compensation, (b) the CQ subscale of Change as an estimate of perceived changes in memory capacity over the past five to ten years, and (c) the CPRS item of observed deficit awareness. These measures were correlated with the MMSE to test the hypothesis that higher levels of general intelligence will be related to a greater degree of awareness than lower levels. The results showed that awareness as measured by the CPRS awareness item was related to the MMSE measure of intelligence, while the total CQ score was not. The importance of this result can be understood by realizing that the CQ and the CPRS provide measures of different types of awareness as described by Cavanaugh (1989). The CQ largely measures epistemic awareness, or the ability to judge the match between environmental demands and ability. On the other hand, the CPRS provides a measure of on-line awareness as judged by a clinician during the assessment. Thus, the results of this study suggest that on-line awareness may be more closely related to psychometric measures of intelligence than epistemic awareness.

Dividing the entire sample into groups defined solely

by the level of cognitive impairment as measured by the MMSE allowed a closer inspection of the relations between measured intellectual abilities and deficit awareness. The results of the analysis indicated that subjects scoring in the impaired range on the MMSE (less than 26) showed less awareness of deficits than the normal functioning group. These results support the hypothesis that impaired subjects are less aware of deficits than those with unimpaired cognitive functioning. In addition, these results suggest that there may be a common aspect of awareness shared by the CQ and the CPRS. This relationship did not change over the six month period between the two assessments.

The results of this study show that subjects who have higher levels of cognitive impairment, primarily those diagnosed with AD, show less awareness of deficits than their unimpaired counterparts. However, it must be kept in mind that this comparison is relative and does not suggest that the impaired or the AD sample are not aware of deficits on any level. As discussed earlier, the sample diagnosed with AD (all of whom scored in the impaired range) are in the early stages of dementia when their level of deficit awareness is higher than at other phases of the disease (Reisberg et al., 1986). It was therefore hypothesized that the AD sample would present a higher level of depressive symptoms, in reaction to their awareness of cognitive decline, than healthy participants in this study.

Depression

The CPRS DSM-based depression scale was used to assess levels of depressive symptoms in this sample. The analyses are carried out with the qualification that severely depressed subjects were excluded from this study, as were all participants suffering from psychiatric disorders. Although this limitation does not preclude the possibility of significant differences in levels of depressive symptoms, the analyses did not find support for the hypothesis that participants diagnosed with AD would present higher levels of depressive symptoms than healthy participants. The healthy and AD samples had similar levels of depressive symptoms on Occasion 1, and this remained consistent through the second occasion (six months later). It must also be considered that the sample of this study was composed of volunteer participants who were required to travel to a research facility for assessment on five occasions over a two year period. The characteristics of depression suggest that it is unlikely that depressed individuals would be motivated to voluntarily undertake such a large commitment. The low level of depressive symptoms measured in this study would support this possibility.

It is interesting to note that the depression scores of the healthy subjects showed a significant increase between Occasion 1 and Occasion 5. However, as measures of intelligence and deficit awareness remained stable over this

time frame the data do not provide an explanation for the increase in depression scores.

The CPRS DSM-based depression scale includes two ratings of depression. The self-report scale is composed of 11 items assessing aspects of depression such as pessimistic thoughts and reduced appetite. The observed scale contains three items that are rated by the clinician during the assessment, including ratings of sadness, motivation, and agitation. Cohen (1990) suggests that it is more difficult to assess depression in the very old, as many clinicians and elderly clients expect very old people to normally present these symptoms, leading to an underestimate of depression in this population. As the healthy and AD groups had similar levels of depression a finer analysis was conducted to establish whether or not the two groups also had similar scores on the observed ratings of depression and the self-reported symptoms. The results indicated that healthy and AD subjects had similar levels of self-reported symptoms, but clinicians observed more depressive symptoms in the AD group than the healthy. The effect size of this findings was small and clinicians may more readily attribute depression to older adults who are diagnosed with AD than healthy older adults. Ratings of depression were determined by the clinician who established the diagnoses of dementia, limiting the validity of this finding.

The literature on the effects of depression on WAIS-R

scores of young adults suggests that depression reduces PIQ scores (Sackeim et al., 1992). The results of the current study support this finding, controlling for the nonsignificant effects of age. Depression had little effect on VIQ scores, while the diagnosis of AD accounted for much of the 22% variance claimed jointly by depression and diagnosis. On the other hand, the effect of depression on the PIQ scores was significant and, combined with a diagnosis of healthy or AD, accounted for 27% of the variance in this measure of fluid intelligence. It is expected that the ability to reason through novel and complex problems would be affected by a condition that slows cognitive processes and reduces motivation.

Although it was expected that depressive symptoms would have an effect on the MMSE scores, it was surprising that depression and diagnosis accounted for over 50% of the variance. These results indicate that while the MMSE is very sensitive to cognitive changes associated with dementia, it also has a high sensitivity to the cognitive impact of depression. Thus, the MMSE would not be a useful tool in distinguishing between these two common pathological illnesses in the elderly.

Investigation of relations between depression and awareness showed a similar dichotomy between the CPRS observer-rated measure of awareness and the total score of the CQ as a measure of epistemic awareness. Depression

levels in this study were not related to epistemic awareness as measured by the use of compensatory memory strategies, but they did show a significant relation to the CPRS awareness measure. Again, the importance of this finding is limited by the fact that the same clinician rated both the observed symptoms of depression and the CPRS assessment of awareness.

Attrition

As with any longitudinal study, several participants were unable to attend all occasions of assessment. The effects of attrition were assessed, comparing those who withdrew over the course of the study to the those who remained on several variables at the first occasion of assessment. The analyses indicated that the drop-outs did not differ from the remaining sample on years of education, although there was a small but significant difference in age. It is important to note that those remaining in the study did not differ on levels of intelligence, awareness, or depression from those who dropped out. These findings indicate attrition probably did not significantly affect the results. Of course, particularly in the case of the AD sample, it would have been preferable if all participants could have attended all occasions of assessment and completed all measures, an unlikely scenario with any study, particularly when the participants who were at least 77 years old at the beginning of the study.

Conclusion

With the average age of the populations in Western countries increasing, the demand for research to enhance our understanding of changes associated with normal and pathological aging, also increases. This study has attempted to address a select set of questions related to these issues.

First, differences in the performance of healthy adults and those diagnosed with AD on standardized measures of intelligence was investigated. Results show that these measures are reliable tools for the assessment of very old adults, and that they can differentiate between those in the early stages of AD and normal elderly individuals.

Second, the use of memory strategies and how they relate to general intelligence was examined. It was found that the group diagnosed with AD used fewer and different memory strategies than their healthy counterparts. The investigation of these issues contributes to the greater scientific understanding of memory skills and how they may be supported in late adulthood. Such research may contribute to the development of training programs to enhance the memory performance of those experiencing deficits by providing a systematic assessment of their strategy use. Future research designed to study the effects of training mildly demented AD patients who can no longer spontaneously utilize the memory strategies commonly used by

their healthy counterparts would be useful to extend this knowledge base. In addition, the inclusion of objective measures of memory would allow researchers to determine the relative impact of perceived and actual memory performance on the use of memory aids.

Third, I investigated the relations between general intelligence and measures of awareness. The results showed a moderate relationship between intelligence and on-line awareness as assessed by a clinician, but it appears that the relationship with epistemic awareness is more tentative. As predicted, subjects in our sample who experienced greater levels of cognitive deficits were less aware of their dysfunction than nonimpaired subjects. It is suggested that future research continue this line of investigation by increasing the sample of participants diagnosed with AD to allow for more powerful contrasts, and by including on-line measures of awareness gained through laboratory tasks.

Fourth, as awareness of decline is often related to depression in patients with neurological disorders, this study attempted a limited investigation of the relationship between depression and awareness. While the results indicated that depression may be more closely linked to on-line awareness than to other forms, the possibility that this finding is inflated by clinician bias must be considered. There were no significant differences between the level of depressive symptoms in the AD sample and the

healthy group. Depression was shown to have an impact on two measures of intelligence in this study, the PIQ and the MMSE, underlining the importance of considering the impact of affect on cognitive abilities when diagnosing dementia in the elderly. Further research into the possibility that deficit awareness is linked to depression in very old people is needed to answer the questions surrounding this issue. In addition, the possibility that cognitive rehabilitation strategies may help alleviate the symptoms of depression in this population should be investigated.

Although the participants in this sample were selected for good health at the initial assessment, it should be noted that the number of AD participants was representative of the percentage of AD in the general population. This suggests that this study provided a close approximation of random sampling in this age group. For the purpose of investigating the relations between changes in general intelligence, use of compensatory strategies and awareness of deficits in AD, a larger group of demented participants is needed to increase the reliability of the findings. Future research with a large sample of mildly demented AD participants is needed to provide a more reliable contrast between healthy and demented very old adults.

These data provided a rich source of information about the aging process, in both healthy and demented very old adults. An unexplored area of the data for the current

study was the development of new cases of AD. At a later date these data will be investigated to examine the factors predictive of the development of Alzheimer's disease in very old adults. Research of this nature will provide insight into the subtle changes in cognition, awareness and affect prior to a diagnosis of AD.

In this study I investigated changes in the cognitive performance of very old adults on tests of intelligence, memory compensation, awareness, and depression over two years. As expected, the healthy participants scored higher on tests of intelligence, reported greater use of memory strategies, and had higher levels of deficit awareness than the participants in the early stages of AD.

It is encouraging to note that although the healthy participants in this study were over the age of 77 years at the commencement of data collection, they generally maintained their level of cognitive performance over the two years of assessment. These results should provide a strong impetus for the maintenance of a healthy lifestyle and preventative health care throughout the lifespan.

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Table 1

Subsample Characteristics for Occasion 1

Subsample	N	Age	MMSE	Gender (F:M)	Education (Years)
			Healthy		
1	95	81.78	28	71:24	9.68
(SD)		(3.07)	(2.15)		(3.69)
2	85	81.80	28	66:19	9.94
(SD)		(3.14)	(1.75)		(3.81)
3	69	81.42	28	55:14	9.78
(SD)		(3.18)	(1.80)		(3.70)
4	48	81.54	29	38:10	9.92
(SD)		(3.26)	(1.10)		(3.84)
5	85	81.80	28	66:19	9.94
(SD)		(3.14)	(1.75)		(3.81)

Table 1 continued

Subsample	N	Age	MMSE	Gender (F:M)	Education (Years)
			Demented		
1	11	82.00	23	8:3	10.00
(SD)		(3.16)	(3.82)		(5.14)
2	21	81.81	25	13:8	8.81
(SD)		(2.82)	(3.65)		(3.92)
3	19	81.90	25	11:8	9.00
(SD)		(2.64)	(2.43)		(4.10)
4	5	81.20	23	3:2	11.40
(SD)		(3.78)	(3.24)		(6.35)
5	11	82.00	23	8:3	10.00
(SD)		(3.16)	(3.82)		(5.14)

Table 2

Selected CPRS Items and Depression Scoring Criteria

Self-report	Observed
Part A	
Sadness	Sadness
Depressive thought	
Part B	
Low emotional engagement	Motivation
Social withdrawal	
Lack of sleep	Agitation
Negative self-evaluation	
Diminished ability to concentrate	
Suicidal thought	
Reduced appetite	
Pessimistic thought	
Slowness of movement	

Note. DSM-III-R scoring criteria: Part A counted as positive if one or more of the following items has a score of one or more. Part B counted as positive if four or more of the following items has a score of one or more.

Table 3

The Seven Scales of the CQ

Use of external memory aids (8 items)

Example: "Do you use shopping lists when you go shopping?"

Use of internal memory strategies (10 items)

Example: "Do you take time to go through and reconstruct an event you want to remember?"

Reliance on others (5 items)

Example: "When you want to remember the name of a particular person, do you ask somebody else (for example, spouse or friend) to help you remember?"

Investment of time (5 items)

Example: "When you want to remember a story do you read it more than once?"

Effort expended (6 items)

Example: "Do you put in a lot of effort when you want to remember an important conversation with a person?"

Criteria for success (5 items)

Example: "When you want to remember a newspaper article is it important to you to remember it perfectly?"

Change in compensatory strategy use (6 items)

Example: "Do you use such aids for memory as notebooks or putting things in certain places more or less often today compared to 5-10 years ago?"

Table 4

Study Design

	Occasions				
Test	1 initial	2 6 mo.	3 12 mo.	4 18 mo.	5 24 mo.
MMSE	X	X	X	X	X
WAIS-R	X		X		X
CPRS	X	X	X	X	X
CQ	X	X	X	X	X

Note. MMSE is the Mini-Mental State Exam; WAIS-R is the Wechsler Adult Intelligence Scale - Revised; CPRS is the Comprehensive Psychopathological Rating Scale; CQ is the Compensation Questionnaire.

Table 5

WAIS-R Test-Retest Reliability Correlations for Subsample 4 of Healthy Participants

Occasion	3 (n)	5 (n)
	VIQ subscale	
1	.85 (51)	.80 (46)
3	--	.86 (43)
	PIQ subscale	
1	.83 (52)	.84 (46)
3	--	.90 (43)
	Information subtest	
1	.87 (52)	.86 (47)
3	--	.90 (44)
	Digit Span subtest	
1	.70 (53)	.66 (46)
3	--	.80 (43)
	Similarities subtest	
1	.65 (52)	.58 (47)
3	--	.64 (44)

Table 5 continued

Occasion	3 (n)	5 (n)
	Picture Completion subtest	
1	.61 (52)	.63 (46)
3	--	.76 (43)
	Picture Arrangement subtest	
1	.49 (52)	.33 (46)
3	--	.61 (43)
	Blocks subtest	
1	.76 (52)	.82 (46)
3	--	.85 (43)
	Digit Symbol Substitution subtest	
1	.79 (52)	.72 (46)
3	--	.88 (43)

Table 6

Test-retest Correlations of the MMSE for the Healthy and Demented Participants in Subsample 4

Occasion	2	3	4	5
		Healthy		
1	.79	.72	.58	.66
(n)	(69)	(63)	(65)	(63)
2	--	.66	.37	.61
(n)	--	(58)	(59)	(57)
3	--	--	.60	.68
(n)	--	--	(56)	(55)
4	--	--	--	.65
(n)	--	--	--	(60)
		Demented		
1	.54			
(n)	(19)			

Table 7

Coefficient Alpha for the CQ Scales for Subsample 2

Occasion	1	2	3	4	5
			External		
Healthy	.64	.54	.71	.62	.74
(n)	(81)	(67)	(51)	(62)	(59)
Demented	.71	.70	--	--	--
(n)	(17)	(14)	--	--	--
			Internal		
Healthy	.82	.75	.74	.71	.81
(n)	(69)	(64)	(50)	(63)	(57)
Demented	.80	.76	--	--	--
(n)	(16)	(14)	--	--	--
			Time		
Healthy	.60	.66	.73	.59	.70
(n)	(83)	(67)	(52)	(62)	(60)
Demented	.51	.05	--	--	--
(n)	(17)	(15)	--	--	--

Table 7 continued

Occasion	1	2	3	4	5
			Reliance		
Healthy	.70	.77	.78	.83	.74
(n)	(80)	(67)	(52)	(63)	(59)
Demented	.88	.83	--	--	--
(n)	(20)	(15)	--	--	--
			Effort		
Healthy	.74	.69	.75	.71	.75
(n)	(77)	(64)	(51)	(63)	(60)
Demented	.79	.60	--	--	--
(n)	(17)	(15)	--	--	--
			Success		
Healthy	.74	.69	.83	.84	.86
(n)	(74)	(63)	(50)	(63)	(60)
Demented	.75	.67	--	--	--
(n)	(18)	(15)	--	--	--

Table 7 continued

Occasion	1	2	3	4	5
			Change		
Healthy	.58	.66	.83	.62	.80
(n)	(79)	(66)	(50)	(63)	(58)
Demented	.86	.37	--	--	--
(n)	(18)	(16)	--	--	--

Table 8

Compensation Questionnaire Test-retest Correlations

	Healthy			
Occasion	2	3	4	5
	External			
1	.74	.74	.50	.70
(n)	(68)	(52)	(63)	(60)
2	--	.82	.65	.85
(n)	--	(46)	(58)	(54)
3	--	--	.79	.87
(n)	--	--	(45)	(42)
4	--	--	--	.73
(n)	--	--	--	(56)

Table 8 continued

	Healthy			
Occasion	2	3	4	5
	Internal			
1	.79	.72	.62	.66
(n)	(68)	(51)	(63)	(60)
2	--	.80	.73	.67
(n)	--	(45)	(58)	(54)
3	--	--	.64	.66
(n)	--	--	(44)	(41)
4	--	--	--	.68
(n)	--	--	--	(56)

Table 8 continued

	Healthy			
Occasion	2	3	4	5
	Time			
1	.64	.64	.61	.62
(n)	(68)	(52)	(63)	(60)
2	--	.74	.62	.65
(n)	--	(46)	(58)	(54)
3	--	--	.73	.70
(n)	--	--	(45)	(42)
4	--	--	--	.70
(n)	--	--	--	(56)

Table 8 continued

	Healthy			
Occasion	2	3	4	5
	Reliance			
1	.56	.60	.53	.59
(n)	(66)	(52)	(62)	(60)
2	--	.40	.51	.61
(n)	--	(46)	(57)	(53)
3	--	--	.64	.64
(n)	--	--	(45)	(42)
4	--	--	--	.66
(n)	--	--	--	(56)

Table 8 continued

	Healthy			
Occasion	2	3	4	5
	Effort			
1	.41	.72	.56	.65
(n)	(68)	(52)	(63)	(60)
2	--	.57	.44	.51
(n)	--	(46)	(58)	(54)
3	--	--	.68	.74
(n)	--	--	(45)	(42)
4	--	--	--	.69
(n)	--	--	--	(56)

Table 8 continued

	Healthy			
Occasion	2	3	4	5
	Success			
1	.51	.63	.71	.64
(n)	(68)	(50)	(63)	(60)
2	--	.63	.65	.55
(n)	--	(44)	(58)	(54)
3	--	--	.84	.64
(n)	--	--	(43)	(40)
4	--	--	--	.77
(n)	--	--	--	(56)

Table 8 continued

	Healthy			
Occasion	2	3	4	5
	Change			
1	.62	.58	.42	.32
(n)	(68)	(51)	(63)	(60)
2	--	.71	.42	.51
(n)	--	(45)	(58)	(54)
3	--	--	.72	.71
(n)	--	--	(44)	(41)
4	--	--	--	.60
(n)	--	--	--	(56)
	Demented			
	External			
1	.67	--	--	--
(n)	(15)	--	--	--
	Internal			
1	.46	--	--	--
(n)	(15)	--	--	--

Table 8 continued

	Demented			
Occasion	2	3	4	5
	Time			
1	.29	--	--	--
(n)	(15)	--	--	--
	Reliance			
1	.65	--	--	--
(n)	(15)	--	--	--
	Effort			
1	.71	--	--	--
(n)	(15)	--	--	--
	Success			
1	.74	--	--	--
(n)	(15)	--	--	--
	Change			
1	.35	--	--	--
(n)	(15)	--	--	--

Table 9

Cronbach's Alpha for the CPRS Depression Scale (DSM-based) for Healthy and AD Participants in Subsample 2

Occasion	Healthy	(n)	AD	(n)
1	.58	(83)	.26	(20)
2	.77	(49)	.21	(15)
3	.74	(61)	--	--
4	.73	(59)	--	--
5	.88	(57)	--	--

Table 10

Test-retest Correlations for the CPRS Depression Scale (DSM-based) for Participants in Subsample 4

		Occasion			
Diagnosis		2	3	4	5
Healthy	1	.46	.23	.40	.52
	(n)	(51)	(62)	(60)	(63)
	2	--	.73	.66	.65
	(n)	--	(46)	(38)	(40)
	3	--	--	.62	.57
	(n)	--	--	(52)	(54)
	4	--	--	--	.59
	(n)	--	--	--	(60)
AD	1	.09	--	--	--
	(n)	(16)	--	--	--

Table 11

Mean VIQ and PIQ Scores for Subsample 4

Occasion	1	3	5
	VIQ		
Healthy (*n* = 42)			
M	28.76	28.41	29.14
SD	5.88	6.39	7.11
AD (*n* = 4)			
M	19.75	16.50	14.25
SD	.50	1.29	2.50
	PIQ		
Healthy (*n* = 42)			
M	25.79	26.38	24.50
SD	6.04	7.69	7.00
AD (*n* = 4)			
M	16.75	15.5	16.25
SD	4.03	2.65	2.99

Table 12

Means of the PIQ/VIQ Ratio Scores

Occasion	Healthy n = 42	AD n = 4
1	.90	.85
	(.17)	(.22)
3	.93	.94
	(.17)	(.14)
5	.84	1.18
	(.16)	(.38)

Table 13

Means of the CQ Subscales Across Two Occasions for Subsample 3

Occasion	1	2
	External	
Healthy	3.91 (.66)	3.95 (.61)
n = 68		
AD	3.50 (.83)	3.39 (.93)
n = 15		
	Internal	
Healthy	2.50 (.73)	2.53 (.71)
n = 68		
AD	2.42 (.68)	2.38 (.70)
n = 15		
	Investment of Time	
Healthy	2.56 (.78)	2.62 (.92)
n = 67		
AD	2.41 (.63)	2.58 (.56)
n = 13		

Table 13 continued

Occasion	1	2
	Reliance on Others	
Healthy	1.72 (.64)	1.58 (.66)
n = 66		
AD	1.77 (.82)	2.10 (1.15)
n = 15		
	Effort	
Healthy	2.58 (.86)	2.58 (.81)
n = 68		
AD	2.23 (.85)	2.39 (.72)
n = 15		
	Criteria for Success	
Healthy	3.04 (1.00)	3.06 (1.03)
n = 68		
AD	3.36 (1.10)	3.26 (.97)
n = 15		

Table 13 continued

Occasion	1	2
	Total CQ	
Healthy	2.73 (.53)	2.72 (.52)
n = 68		
AD	2.62 (.52)	2.69 (.50)
n = 15)		

Table 14

Means of CQ Responses for Healthy Subjects Across Five Occasions

	Occasion				
Scale	1	2	3	4	5
External					
n = 35	3.90	3.94	3.86	3.91	3.87
(SD)	(.68)	(.65)	(.77)	(.73)	(.83)
Internal					
n = 34	2.47	2.42	2.61	2.61	2.62
(SD)	(.79)	(.70)	(.66)	(.75)	(.84)
Time					
n = 34	2.57	2.59	2.60	2.78	2.79
(SD)	(.74)	(.96)	(.83)	(.80)	(.78)
Reliance on Others					
n = 35	1.73	1.40	1.86	1.87	1.75
(SD)	(.65)	(.53)	(.76)	(.71)	(.62)
Effort					
n = 35	2.56	2.59	2.82	2.88	2.77
(SD)	(.83)	(.76)	(.91)	(.88)	(.91)

Table 14 continued

	Occasion				
Scale	1	2	3	4	5
Criteria for Success					
n = 33	3.02	3.04	3.19	3.12	2.97
(SD)	(1.07)	(1.10)	(1.02)	(1.12)	(1.32)
CQ Total					
n = 35	2.72	2.67	2.82	2.87	2.80
(SD)	(.58)	(.54)	(.60)	(.60)	(.63)

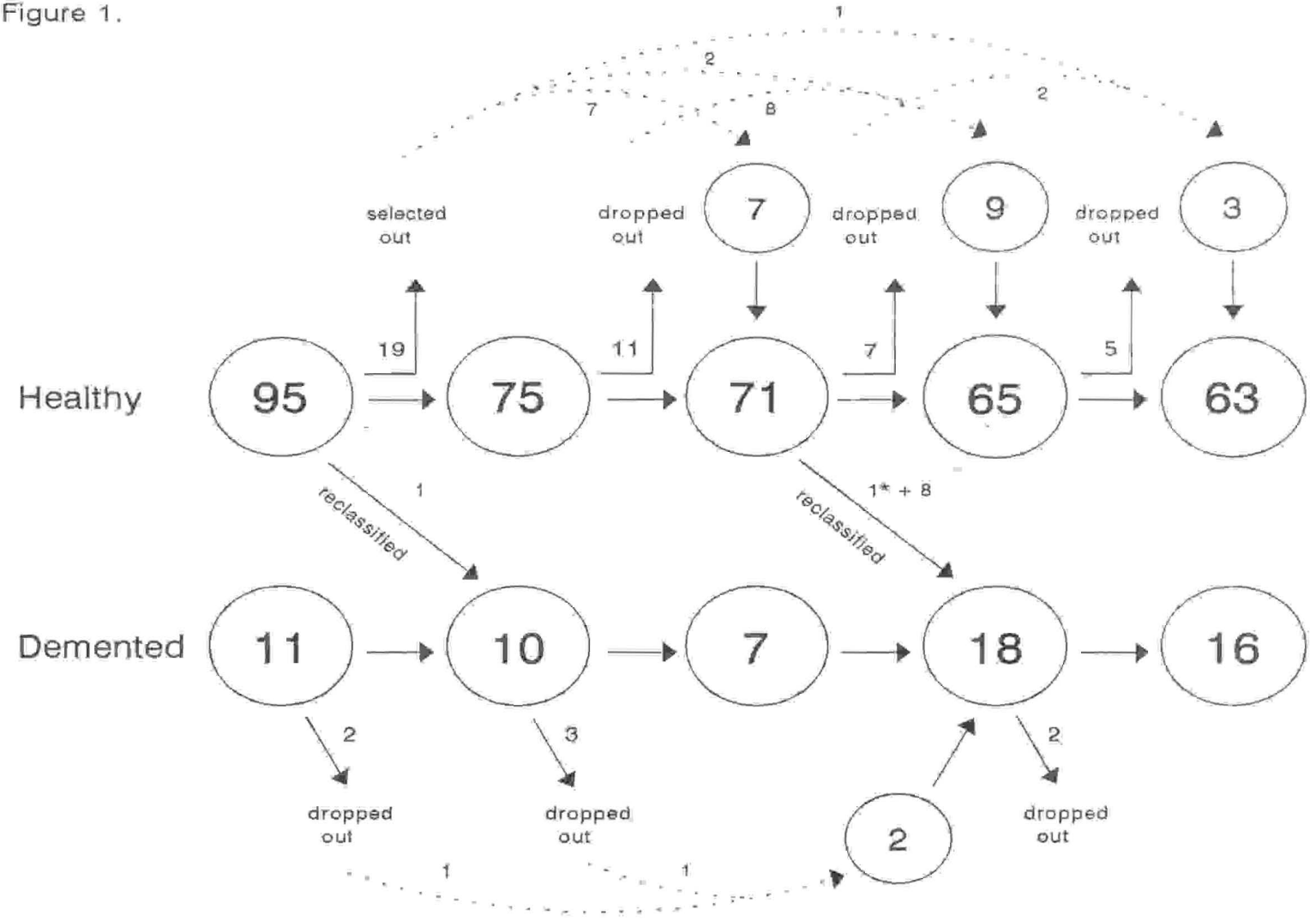
Table 15

Correlations of Healthy and AD MMSE and Awareness of Deficit Scores

Occasion	1	2	3	4	5
r	-.52	-.78	-.63	-.42	-.54
(*n*)	104	63	77	77	77

p < .001.

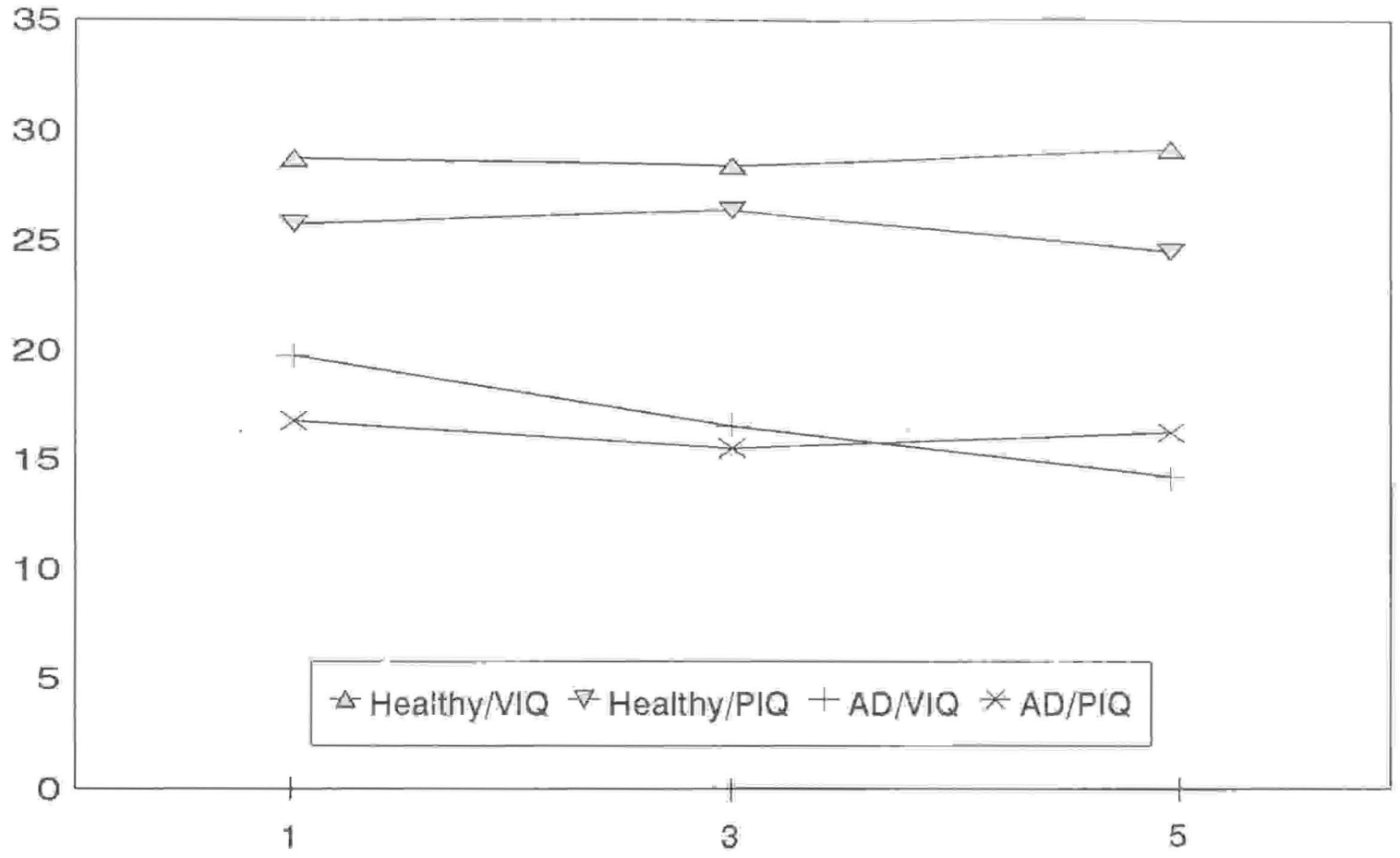
Figure 1.



Enrollment of healthy and demented participants at 5 occasions of assessment

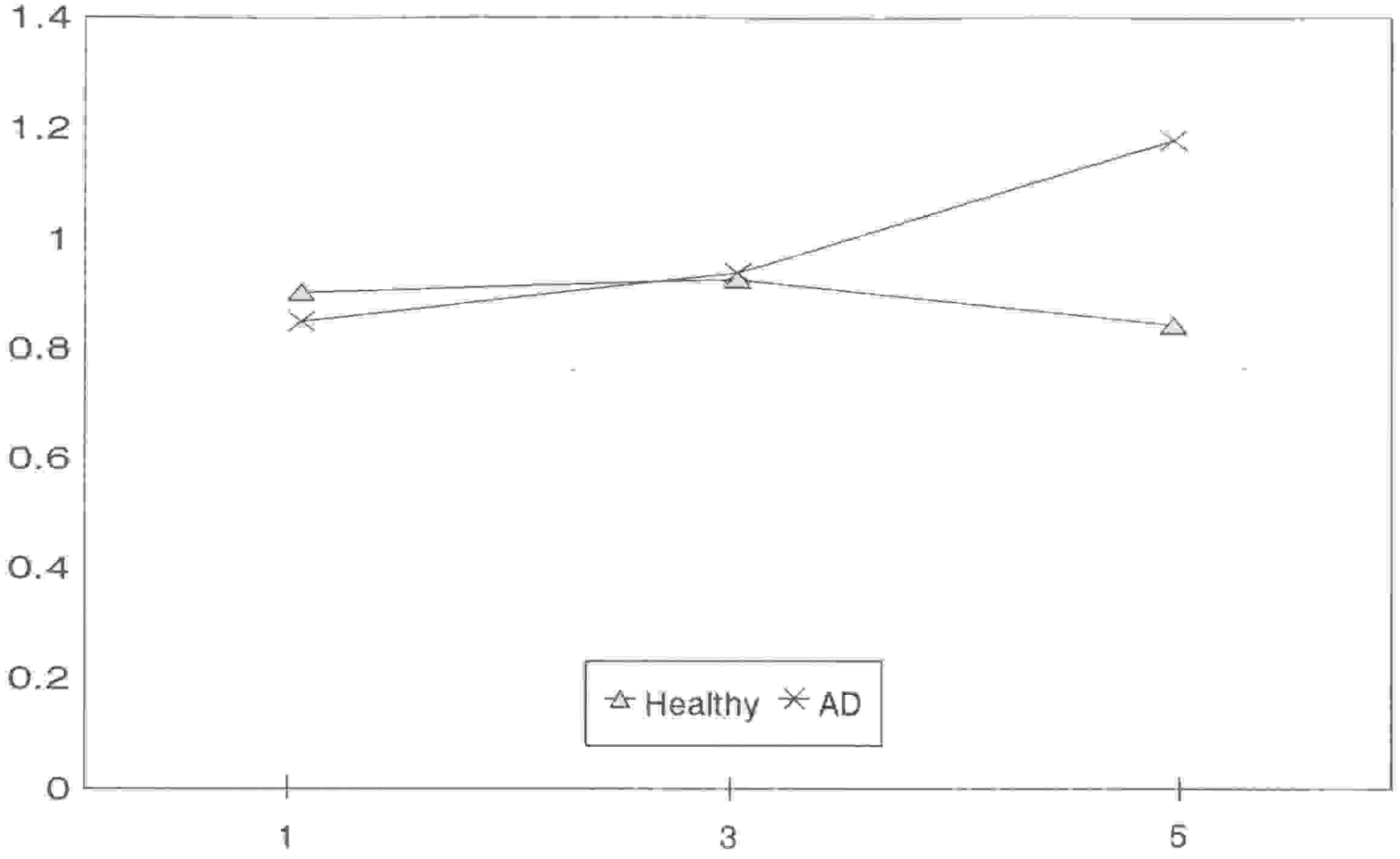
* Reentered after occasion 3.

Figure 2.



VIQ and PIQ for the Healthy and the Demented Participants from Subsample 4 over Two Years

Figure 3.



PIQ/VIQ Ratio for the Healthy and the Demented Participants from Subsample 4 over Two Years

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GRACE A. HOPE

APRIL 20, 1995