UNDERAWARENESS OF DEFICIT IN ALZHEIMER'S DISEASE: CONVERGENT VALIDATION OF METAMEMORY TASKS AND THE RELATIONSHIP TO RISKY BEHAVIOR

by

Lisa Marie Duke

A Dissertation Submitted to the Faculty of the

DEPARTMENT OF PSYCHOLOGY

In Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

2 0 0 0

UMI Number: 9983892

Bell & Howell Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

THE UNIVERSITY OF ARIZONA ®
GRADUATE COLLEGE

As members of the Final Examination Committee, we certify that we have read the dissertation prepared by Lisa Marie Duke

entitled Underawareness of deficit in Alzheimer's disease: Convergent validation of metamemory tasks and the relationship to risky behavior

and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of Doctor of Philosophy

Alfred Kaszniak	**Date** 8/3/00
Elizabeth Glisky	**Date** 8/3/00
Lee Ryan	**Date** 8/3/00
Kris Kaemingk	**Date** 8/3/00
John J.B. Allen	**Date**

Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copy of the dissertation to the Graduate College.

I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

Dissertation Director	**Date** 8/3/00
Alfred Kaszniak	

STATEMENT BY AUTHOR

This dissertation has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this dissertation are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Lisa Marie Cuke

TABLE OF CONTENTS

TABLE OF CONTENTS – *Continued*

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Underawareness of memory impairment in Alzheimer's disease (AD) was examined using three experimental methodologies: the feeling-of-knowing (FOK) paradigm, the performance prediction/postdiction paradigm (PPP), and patient-caregiver discrepancy on questionnaire (QD). For the FOK paradigm, thirty-two AD patients and their spouses were given an episodic (sentence) memory task, during which they were asked to recall the sentences' final words and to make retrospective confidence judgements about their recall attempts. For failed items, participants rated their future likelihood of correctly recognizing each ending (FOK). Participants' ratings were compared to actual recall or recognition scores. Results revealed that AD patients were less accurate than their non-demented spouses in making retrospective recall and prospective FOK ratings. Similarly, results from the PPP showed that AD patients overestimated their own performance relative to their caregivers' performance on a list learning and memory task, more than caregivers did. Contrary to prior research, participants' responses on questionnaires concerning their own and their spouses' memory change showed that AD patients reported less memory change for both themselves and their caregivers.

The paradigms were hypothesized to differ in the extent to which they require different aspects of metamemory ability. Because both require on-line memory monitoring ability, it was hypothesized that the FOK and PPP would be most related, while the QD was predicted to be relatively independent, relying more on generalized self-memory beliefs. A principal components analysis confirmed that the questionnaire data was relatively independent from the other two methodologies. However, the

prospective FOK ratings loaded on a different component than the retrospective ratings and the PPP variables. Memory monitoring may be dissociable by task, with prospective ratings relying more on inferential processes, thought to depend on frontal lobe functioning.

In order to examine the relationship between underawareness and risky behavior, caregivers were administered a novel interview during which they rated the patients' propensity to attempt various activities, as well as the riskiness of each behavior. Contrary to expectation, riskiness was not significantly correlated with underawareness, but was associated with greater impairments of activities of daily living.

INTRODUCTION

The ability to be aware of and to contemplate one's cognitive functioning is referred to as *metacognition* (Flavell, 1979). Self-reflection about perceptions, feelings, thoughts, and actions has long been of central importance to philosophers (Nelson, 1996). Yet, owing to the domination of behaviorism within the field of psychology during the early and middle part of this century, only of late has conscious awareness become a popular and acceptable subject-matter within psychology (Kaszniak & Zak, 1996; Tulving, 1994). Increasingly, scientists have returned to consciousness, which Tulving (1994, p. ix) pointed out is a "necessary condition" of metacognitive ability, as an acceptable area of inquiry (Hameroff, Kaszniak, & Scott, 1996; Nelson, 1996, Tulving, 1994). While early introspectionists focused on the phenomenology of consciousness and metacognition (Nelson, 1996), contemporary empirical investigations into consciousness have begun to explore not only cognitive operations involved, but also potential neurobiological correlates (Kaszniak & Zak, 1996).

Neuropsychological investigations into the nature of metacognition have sought to identify neurological disorders which impact upon metacognitive ability and to infer which brain regions might be involved in awareness of cognitive functioning. Impaired insight for disease state, which may involve both physical and psychological symptoms, has been referred to as *anosognosia* (Babinski, 1914). Excellent reviews of anosognosia or impaired awareness in neurological conditions such as hemiplegia resulting from stroke, head injury, Korsakoff's disease, dementia, and schizophrenia are available

(Kaszniak & Zak, 1996; McGlynn & Kaszniak, 1991a; McGlynn & Schacter, 1989).

Patients with Alzheimer's disease (AD), the most prevalent dementing illness. offer a unique opportunity to study the nature of impaired awareness. Early in the disease course, some Alzheimer patients may demonstrate acute awareness of their memory impairment, while as the disease progresses awareness may become impaired. Nonetheless, some AD patients maintain their awareness even in the later stages of the illness. Because awareness is not uniformly disturbed in AD, it is possible to take advantage of this interindividual variation in awareness of deficit among AD patients by examining neuropsychological and neuropathological differences among patients with and without anosognosia. Studies of anosognosia in degenerative dementias have focused on awareness of memory impairment, as well as on awareness of other features of the illness, such as independent living skills and depression.

After a brief overview of the diagnosis and neuropathology of Alzheimer's disease, the present paper reviews neuropsychological studies of impaired awareness in AD. Emphasis is placed upon different methodologies utilized to assess awareness in this population, following Kaszniak & Zak (1996). Finally, the practical implications of impaired awareness of deficit in AD are discussed, and available data concerning risky behaviors in AD patients are reviewed.

A study is then described which extends previous investigations into impaired awareness of deficit in AD. The present study examines the convergent validity of the feeling-of-knowing paradigm as an index of awareness in Alzheimer's patients. In addition, the relationship between risky or dangerous behavior of AD patients and awareness is explored, using a novel caregiver interview.

Alzheimer's Disease: Diagnosis, Clinical Features, and Neuropathology

Alzheimer's disease (AD), a degenerative dementing illness, accounts for roughly 50 percent of all cases of dementia, making it the most common presentation of dementia (see Cummings & Benson, 1992). According to diagnostic guidelines developed by the American Psychiatric Association (1994), dementia is characterized by impairments in long-term and short-term memory, as well as deficits in one or more other areas of cognition: aphasia, apraxia, agnosia, or a disturbance in executive functioning. The cognitive impairments must impair occupational or social performance and also must be indicative of a decline from the individual's previous abilities. Moreover, the observed cognitive compromise must not occur solely during the experience of delirium, nor should it be attributable to a reversible cause of dementia, such as endocrine or metabolic disturbance or depression. A work group sponsored by the National Institute of Neurological and Communicative Diseases and Stroke and by the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) developed additional diagnostic guidelines for AD that stress the importance of ruling out other brain disorders which may cause dementia, including: cerebrovascular disease, tumors, trauma, and other degenerative dementing illnesses such as Parkinson's disease (McKhann et al., 1984).

With an age of onset between 40 and 90, the clinical course of AD has been described as insidious and progressive (McKhann et al., 1984). Early in the disease process, memory impairment, especially of explicit, recent memory, is usually the most prominent symptom. Impairments in remote memory and in other areas of cognition develop with further progression of the disease (Hyman, Arriagada, Van Hoeson, & Damasio, 1993; Whitehouse, Lerner, & Hedera, 1993). Observed impairments in activities of daily living, a family history of similar disorders, normal findings on lumbar puncture, and normal or nonspecific EEG findings may support a diagnosis of AD (McKhann et al.). Computerized tomography (CT) or magnetic resonance imaging (MRI) results may be normal for the person's age, especially early in the course of the illness, or may show cerebral atrophy which progresses over time (McKhann et al.). The clinical syndrome may include psychiatric symptoms and behavioral disturbances, particularly later in the course of the illness. Depression, disturbances in diurnal variation, incontinence, delusions, hallucinations, psychomotor agitation, irritable affect, sexual disorders, and weight loss may be observed (Gilley, 1993; McKhann et al.).

A neuropathological study is required in order to establish a definitive diagnosis of AD (Khachaturian, 1985). LaRue (1992) and Bondi, Salmon, & Kaszniak (1996) provide useful reviews of the neuropathological changes in AD. Age-disproportionate atrophy, preferentially affecting temporal, parietal, and frontal association areas of the brain, is frequently found (Terry et al., 1991; Terry, Peck, DeTeresa, Schecter, & Horoupian, 1981). Neuronal and synaptic loss occurs in these cortical regions and is particularly prominent in the hippocampus, the entorhinal cortex, the locus coeruleus, and the nucleus basalis of Meynert (Katzman, 1986). Cortical cholinergic levels are reduced, secondary to cell loss in a subcortical structure, the nucleus basalis of Meynert. Cell death in the locus coeruleus results in diminished levels of cortical noradrenergic enzymes (Whitehouse et al., 1982; Bondareff, Mountjoy, & Roth, 1982).

The presence of neuritic plaques, composed of amyloid deposits, and neurofibrillary tangles, present in amounts that exceed what is typically expected from normal aging, also characterize the neuropathology of AD (Katzman, 1986; Khachaturian, 1985; Terry & Katzman, 1983). Plaques and tangles are most pronounced in temporal-parietal and frontal cortical areas, as well as in the hippocampus, entorhinal cortex, and amygdala (Katzman, 1986; Khachaturian, 1985; Terry & Katzman, 1983). It has been suggested that neuroanatomical changes in the hippocampus disconnect this structure from other memory-related cortical and subcortical brain regions (Hyman, Arriagada, Van Hoesen, & Damasio, 1993). Hyman and colleagues theorized that impaired learning of information and short-term recall may result from the development of neurofibrillary tangles in the entorhinal cortex and the hippocampus early in the disease process, while longer-term retrograde memory and other cognitive functions were suggested to become impaired as cortical association areas are increasingly affected.

Impaired Awareness of Deficit in AD

Clinical descriptions of AD patients reveal that some patients were described as being acutely aware of their memory impairment, while others were said to deny that anything was wrong with their memories. Historically, clinical conceptualizations of AD linked underawareness of deficit with the severity and duration of the illness (e.g., Kral, 1983). In the early, "forgetful" stage of AD, patients were said to retain insight into their condition, giving rise to depression and anxiety. As the illness progressed to the "confusional" stage, memory and other cognitive impairment became more severe, and patients were seen as losing insight into their condition (Schneck, Reisberg, & Ferris, 1982). AD patients in the advanced stages of the illness were described as having severe cognitive impairment, disorientation, unawareness, and behavioral disturbances. Thus, clinical observation suggested that impaired awareness of cognitive deficit was associated with the severity of dementia and with duration of illness. Nonetheless, the association between underawareness of deficit and illness duration has been disputed. Some writers reported that awareness is impaired early in the course of the illness (Frederiks, 1985), while others maintained that awareness is not impaired until the later stages of the disease (Schneck et al, 1982; Sevush & Leve, 1993).

Proposed Mechanisms of Anosognosia

Several mechanisms have been proposed to explain underawareness of deficit in AD patients, as well as in patients with other neurological conditions. One proposed theory is that AD patients have such severe memory impairments that they fail to remember their own instances of memory loss in day-to-day life (Hermann, 1982). This failure-to-remember account appears inadequate, though, because some AD patients with severe memory impairment demonstrate accurate awareness (e.g., Weinstein, Friedland, & Wagner, 1994). Other writers have favored a psychodynamic interpretation of unawareness of deficit, suggesting that AD patients have motivated or defensive denial of their deficits: "The forms of denial ... persist because they provide a sense of identity, combat feelings of unreality and unfamiliarity, and impart structure and unity to what would otherwise be masses of confusing data" (e.g.,Weinstein et al., 1994, p. 183).

There are two important problems with the psychodynamic explanation of anosognosia for dementia (McGlynn & Schacter, 1989; Ramanchandran, 1995). First, if AD patients deny their deficits for ego-protective reasons, they should be expected to deny deficits in all areas of functioning. In fact, several recent studies have demonstrated that anosognosia for dementia may vary across cognitive, behavioral, and emotional domains, implying that awareness of deficit is not a unitary construct. These studies have found that AD patients' underawareness is most severe for recent memory and activities of daily living impairments, with less severely impaired awareness or intact awareness for psychiatric symptoms such as depression (Green, Goldstein, Sirockman, & Green, 1993; Kotler-Cope & Camp, 1995; Vasterling, Seltzer, Foss, & Vanderbrook, 1995). A further failing of the psychodynamic explanation of anosognosia is that it cannot explain why underawareness of deficit appears to be associated with damage to certain brain regions. Anosognosia (in general) is more frequent following damage to inferoparietal cortex, frontal cortex, and frontal-subcortical circuits, more common following right than left hemispheric damage, and is uncommon following damage restricted to primary sensory or motor regions of the cortex, lower brain stem regions, and to spinal or peripheral nervous system areas (Bisiach & Geminiani, 1991; Kaszniak & Zak, 1996; McGlynn & Schacter, 1989; Wagner & Cushman, 1994).

According to a review by Kaszniak and Zak (1996), the majority of current theorists of anosognosia espouse neuropsychological explanations of underawareness of deficit. In fact, Weinstein, the principal proponent of the psychodynamic view of anosognosia, recently modified his framework of the phenomenon, differentiating between denial or underawareness of deficit and loss of insight, which was said to be a unitary deficit related to dementia severity (Weinstein et al., 1994). The usefulness and validity of this distinction needs to be explored in further empirical investigations.

McGlynn and Schacter (1989) offered a preliminary neuropsychological view of anosognosia. Their review of clinical reports and experimental studies of underawareness of deficit in various neurological conditions concluded that awareness may rely on the functioning of both frontal and inferior parietal brain regions. Drawing from Schacter's Dissociable Interactions and Conscious Experience (DICE) model, McGlynn and Schacter proposed that the conscious experience of all domains of cognition, including perception, memory, language, and problem solving, depends on a distinct conscious awareness system (CAS). The CAS was thought to receive information from modules for perception, memory, and semantic knowledge, and was said to be engaged only in novel, "change-from-baseline" situations. Selective disconnection of certain cognition modules from the CAS would explain the observations of specificity of underawareness of deficits, while a generalized underawareness would be expected to result from direct damage to the CAS. On a neuroanatomical level, McGlynn and Schacter proposed that the CAS is a posterior system, involving the inferior parietal lobes and their interconnections. Furthermore, in the DICE model, the CAS was hypothesized to be connected to a frontal, executive system, involved in the initiation, planning, and monitoring of complex thoughts and goal-directed behaviors. Thus, according to this model, different types of underawareness of deficits could occur following damage to inferior parietal regions, the frontal lobes, or to the connections between these regions.

Agnew and Morris (1998) proposed a similar cognitive model to explain the heterogeneity of underawareness of memory deficits in AD. Following McGlynn and Schacter (1989), they proposed a theory of underawareness that also addresses the contribution of memory impairment to anosognosia. According to Agnew and Morris, incoming information concerning the event of a memory failure enters short-term memory, where it is experienced, and then proceeds to long-term memory. The event is then compared, using a "mnemonic comparator" within the central executive system (CES), to the semantic "personal knowledge base (PKB)," or one's opinion of his/her memory ability in relation to others. In cases of a mismatch detected by the comparator, the PKB is then updated, and the information from the PKB is directed back into the conscious awareness system (CAS). Agnew and Morris described three types of anosognosic deficits. *Mnemonic anosognosia* results when a memory failure is not encoded into semantic knowledge about the state of one's memory functioning, although the memory failure was initially perceived and detected by the mnemonic comparator. Individuals with this type of impairment may show immediate knowledge of a memory failure through links between the episodic memory system and the CAS, but this immediate knowledge does not impact on the personal knowledge base. Patients with *executive anosognosia* have a faulty memory comparator. Thus, the memory failure is registered in short-term memory, but is never compared with the PKB. Finally, patients with *primary* anosognosia are not aware of the incidence of a memory failure, except through implicit means, in spite of the fact that the comparator of the CES detects the failure. Patients with primary anosognosia do not display domain specific underawareness, as the entire CAS is thought to be affected. Because of their proposal of various potential mechanisms for anosognosia, Agnew and Morris suggested that a case study approach to the study of underawareness is needed for further development of cognitive models of anosognosia.

Newman (1997a, 1997b) offered a more contemporary neuropsychological model of consciousness, which takes into account recent insights into brain functioning made by neuroscience researchers. Newman pointed out that there are no exclusive "centers" in the brain for particular functions, a common misconception: "Any complex function performed by the CNS involves widely-distributed, but strategically interconnected networks of neurons, each contributing in distinctive ways to an overall function (Newman, 1997a, p. 52). Newman described an extended reticular-thalamic activating system (ERTAS), which incorporates sensory inputs into the midbrain reticular formation, with two nuclei (superior colliculi and cunieform nucleus) projecting to the thalamus. These nuclei are thought to integrate polymodal sensory inputs and to represent the three-dimensional "spatial envelope" around the organism. From the midbrain, projections lead to the thalamus, including the intralaminar complex and the nucleus reticularis, which unlike the more specific sensory and motor thalamic nuclei from which its receives input, appear to be largely polymodal and densely interconnected. Thus, the midbrain and thalamus together are said to form the extended system that activates the cortex and gates the information flow into and out of the region. Projections from the thalamus forward to motor and eye movement networks mean that the organism can be altered for response to novel environmental, and likely internal, stimuli. The thalamic nuclei also receive top-down inputs from the cortex, which send approximately 10 times the projections back to the thalamus than it receives. A prefrontal-medial dorsal thalamic nucleus system is implicated in working memory and a posterior cortical-thalamic system is thought to be involved in certain attentional processes. Together with the cortex, then, the ERTAS may be responsible for key functions involved in conscious awareness. According to Newman (1997b), the functioning of the ERTAS is implicit, with the cortex contributing the explicit contents of consciousness.

Given the widespread brain regions that may contribute to conscious awareness, it is clear why prior research has not uncovered one specific brain region that solely is associated with consciousness. Nonetheless, the ERTAS model is consistent with previous reports that underawareness is not observed following damage restricted to primary sensory or motor cortical areas, to lower brain stem regions, or to the spinal cord (Bisiach & Geminiani, 1991; Kaszniak & Zak, 1996; McGlynn & Schacter, 1989; Wagner & Cushman, 1994). Neuroscientists have made great strides in illuminating the neural correlates of consciousness. Yet, models such as ERTAS remain highly controversial (Newman, 1997b). Moreover, the precise mechanisms underlying conscious experience are far from being understood (Newman, 1997b). In addition to contributing to our understanding of the neural correlates of conscious awareness, neuropsychological studies of underawareness in dementia may also offer insight into the nature of awareness of deficit and into the impact of impaired awareness in the daily lives of Alzheimer's patients. The remainder of the review will highlight these issues.

The Nature of Underawareness in Dementia: Systematic Questionnaire and Experimental Designs

Kaszniak and Zak (1996) reviewed the literature on awareness of memory impairment in dementia with an emphasis on the methodologies utilized to operationalize awareness. The earliest reports of impaired awareness in dementia employed clinical ratings. Kaszniak and Zak discussed the limitations of clinical observations. First, such observations have been unsystematic and quite variable, making comparison of studies problematic. Secondly, clinical ratings have been based on nominal or crude ordinal levels of measurement, limiting statistical power to uncover group differences or significant correlations. Furthermore, few patients are completely unaware of impairment, and crude measurement scales fail to reflect subtle gradations of un- or under-awareness. Finally, clinical ratings do little to shed light on the nature of impaired awareness, leaving it unclear whether impaired awareness is due to inaccurate self-efficacy beliefs (see Hertzog & Dixon, 1994), faulty self-monitoring of ongoing cognition and behavior, to some combination of these two factors, or to other unspecified factors.

Apart from clinical ratings, three principal methods have been utilized to operationalize awareness in neuropsychological studies of underawareness of deficit: systematic questionnaire studies, performance prediction, and feeling-of-knowing paradigms. Kaszniak and Zak (1996) provided a thorough discussion of these methods. The systematic questionnaire design involves comparing patient's reports of their own self-impairment in various areas with a caregiver or relative's report of the patient's disability. In the performance prediction method, patient and caregivers are asked to predict how well each other will perform on cognitive tasks, and the patient's actual performance is compared with both his or her own predictions and the relative's predictions. Finally, the feeling-of-knowing paradigm entails making confidence judgements for future responses on immediate or long-term recognition memory tasks.

According to Kaszniak and Zak (1996), each of these three methodologies yields data relevant to different constructs believed to be involved in metamemory processes. Hertzog and Dixon (1994) described three constructs related to metamemory: 1) knowledge concerning the functioning of memory in general and the utility of mnemonic strategies in memory tasks, 2) memory self-monitoring or awareness of one's current memory ability, and 3) memory self-efficacy beliefs or beliefs about one's personal memory ability in general. The systematic questionnaire and performance prediction paradigms address knowledge of memory functioning in general and beliefs about one's own memory functioning. Performance postdictions in particular are also likely require memory self-monitoring. Nonetheless, the feeling-of-knowing paradigm appears to be most relevant to the study of memory self-monitoring ability. This review will now examine evidence and conclusions gained from each of these three paradigms in the study of underawareness in Alzheimer's disease.

Systematic Questionnaire Studies. The first study of underawareness of cognitive deficits using the questionnaire approach was conducted by Reisberg, Gordon, McCarthy, Ferris, and deLeon (1985). Their study compared the self- and relative- reports of 10 individuals with normal cognition, 5 with age-associated mild memory impairment, and 20 patients with Alzheimer's disease. Participants and informants (spouses) were interviewed separately about their own and their spouses' troubles in four areas: memory, emotion, social function, and independent living skills. Participants with normal cognitive ability and patients with only mild age-related memory decline generally agreed with their spouses about their abilities. In contrast, moderately severe Alzheimer's patients rated their memory, independent living ability, and emotional functioning as less severely impaired than did their spouses. AD patients and spouses agreed, however, on ratings of their ability to communicate with one another and on ratings of the spouses' functional abilities. The authors concluded that lack of awareness in AD is restricted to evaluations of the self.

McGlynn and Kaszniak (1991b) elaborated on the questionnaire paradigm. Eight individuals with AD and their relatives rated their own and each other's everyday memory difficulties using three questionnaires, based on questionnaires previously developed by Reisberg et al. (1985) and Schacter and colleagues (McGlynn, Schacter, & Glisky, 1989; Schacter, 1991). The questionnaires utilized 7-point scales, which required participants to rate the degree of difficulty they had on various aspects of memory performance, compared to before the onset of the illness. One questionnaire addressed general memory self-beliefs. A second questionnaire examined everyday memory, asking patients and spouses to rate their own and each other's likelihood of remembering information in 10 specific situations, after varying delays, compared to the likelihood of remembering before the illness onset. If a patient rated his or her present likelihood of recall as similar to their chance of recall prior to the illness, and as similar to their spouses' likelihood of recall, there would be convergent support for underawareness. In addition, the second questionnaire provided evidence concerning patients' knowledge of how memory functions, by assessing their ratings of likelihood of recall across varying delays. Spouses also completed the second questionnaire, enabling a comparative analysis of likelihood ratings. A third questionnaire required patients and spouses to estimate, both for themselves and for each other, how many items they would able to recall from hypothetical 10-item lists of varying difficulty (e.g., familiar and unfamiliar names, paired associates). Ratings were made for both present memory ability and for memory ability prior to the onset of illness, and estimates were also given for each of the above-mentioned delays. Therefore, the third questionnaire enabled comparisons of patients and spouses knowledge of general memory functioning for easy versus difficult items, as well as for each other's memory functioning.

The general pattern of results from the three questionnaires employed in McGlynn and Kaszniak's study indicated that participants with AD rated their own cognitive problems as less severe than their relatives rated the AD patients' memory problems, and this discrepancy increased with the severity of the dementia. Nevertheless, AD patients and relatives agreed on ratings of relatives' memory performance. Therefore, AD patients did not appear to have a general cognitive estimation deficit which would have impaired their ratings of their relative's ability, as well as their own. Based on these results, McGlynn and Kaszniak suggested that AD patients underestimate the severity of their own memory impairment.

Domains of underawareness of deficit. Numerous investigations have employed patient-caregiver discrepancy on questionnaires designed to examine domains of deficit underawareness in AD. Kaszniak, DiTraglia, & Trosset (1993) examined questionnaire discrepancies of 19 mild-to-moderately demented AD patients and their relatives. Questionnaires assessed the frequency and severity of memory problems, as well as other cognitive problems and emotional disturbances. Based on caregiver reports, AD patients underestimated their problems with memory and cognitive dysfunction. AD patients and caregivers nonetheless agreed on the patients' use of mnemonic aids and on the extent of their emotional problems, which were minimal. Other research has identified dissociations in awareness for intellectual impairment, self-care and independent living ability, behavioral problems, and health status (Green et al., 1993; Kotler-Cope & Camp, 1995; Starkstein, Sabe, Chemerinski, Jason, & Leiguarda, 1996; Vasterling et al., 1995). The general pattern of findings supported the assertion that underawareness of deficit is not a unitary phenomenon. AD patients appeared to show poorest awareness of cognitive impairments and better awareness for depressive symptoms.

Underawareness and dementia severity. Review of research utilizing patient-caregiver discrepancy on systematic questionnaires demonstrated that approximately 20% of AD patients may demonstrate anosognosia for cognitive impairment (Migliorelli, Teson, Sabe, Petracca, Petracchi, et al., 1995). Discrepancy studies examined the relationship of impaired awareness to the severity of dementia and to duration of illness, with conflicting results. Many researchers reported that the extent of awareness of deficit increased as the severity of dementia increased, confirming notions based on clinical reports (Anderson & Tranel, 1989; Feher, Mahurin, Inbody, Crook & Pirozzolo, 1991; Mangone et al., 1991; Migliorelli, Teson, Sabe, Petracca, Petracchi, et al., 1995; Ott, Noto, & Fogel, 1996; Reisberg et al., 1985; Seltzer, Vasterling, Hale, & Khurana, 1995; Vasterling, et al., 1995; Starkstein et al, 1996; Verhey, Rozendall, Ponds, & Jolles, 1993). The associations observed in these studies, which used various measures of dementia severity, were generally modest. Nonetheless, numerous studies failed to uncover a significant correlation with disease severity (Correa, Graves, & Costa, 1996; DeBettignies, Mahurin, & Pirozzolo, 1990; Feher, Larrabee, Sudilovsky, & Crook, 1994; Green, Goldstein, Sirockman, & Green, 1993; Kotler-Cope & Camp, 1995; Michon, Deweer, Pillon, Agid, & DuBois, 1994). The variability in the observed associations between questionnaire discrepancy measures of underawareness and dementia severity indicates that severity of dementia alone cannot account for variation in underawareness in dementia. A more methodologically sophisticated study (Wagner, Spangenberg, Bachman, & O'Connell, 1997) compared patient self-report of cognitive impairments during an interview with objective neuropsychological performance across 7 cognitive domains and found that dementia severity was related to anosognosia, but that, independent of severity, dementia type (AD versus vascular dementia) was also a significant predictor of awareness, with AD patients showing greater underawareness than vascular dementia patients, geropsychiatric controls, and geriatric controls.

Underawareness and depression. A related clinical observation, that intact awareness of deficit is associated with depression, has also been debated in the literature. Clinical lore maintained that depression was more common in the early phase of the illness, a psychological reaction resulting from as yet intact awareness of the disease (e.g., Kral, 1983). Several studies supported this notion (Feher, et al.,1994; Pearson, Teri, Reifler, & Raskind, 1989; Seltzer et al.,1995; Starkstein et al., 1996). Others, however, failed to confirm the finding (DeBettignies et al., 1990; Lopez, Becker, Somsak, Dew, & DeKosky, 1994; Verhey et al.,1993) or reported only a "weak" relationship (Feher et al., 1991: $r = -.29$, $p < .09$, p. 140). There has been an interest in the relationship between depression and self-reports of memory, because it was found that self-report of memory problems among elderly adults correlated with negative affect, but not with objective memory performance. Memory performance was, however, correlated with caregivers' reports of these participants' memory difficulty (McGlone et al., 1990).

Addressing methodological weaknesses of some previous studies by using structured diagnostic interviews conducted with patients and caregivers, Migliorelli and colleagues (Migliorelli, Teson, Sabe, Petracca, Petracchi, et al., 1995; Migliorelli, Teson, Sabe, Petracchi, Leiguarda, et al., 1995) found that dysthymia, but not major depression, was more common in 21 AD patients with intact awareness than in 52 anosognosic AD patients. The authors suggested that conflicting results from previous studies may relate to differing patient characteristics, with observed depression scores reflecting a mix of dysthymia and major depression in AD patients. Furthermore, the writers speculated that dysthymia may relate more to a psychological reaction to the disease state in patients with intact awareness, while major depression in AD patients, which was present in AD patients with and without anosognosia, may be due to an underlying neurobiological dysfunction. In another report on data from the same group of subjects, Migliorelli and colleagues (Migliorelli, Petracca, Teson, Sabe, Leiguarda, et al.,1995) found that anosognosia in AD patients was also related to the presence of delusions, which the writers speculated may be related to deficit in self-monitoring. Other reports documented that more severe anosognosia in AD patients was associated with pathological laughing and crying (Migliorelli, Teson, Sabe, Petracca, Petracchi, et al., 1995; Starkstein, Migliorelli, et al., 1995). Whatever the etiology of depressive and other psychiatric symptoms in AD patients, the high incidence of the depression in this population suggests that future neuropsychological studies of this issue should incorporate structured psychiatric ratings, in order to permit examination of the effect of psychiatric symptoms on cognitive functioning.

Underawareness and the frontal lobes. Ott, LaFleche, et al. (1996) suggested that underawareness is related to cognitive function, but to specific rather than to global measures; underawareness of deficit was strongly associated with a measure of executive function and visuospatial ability in their study. The finding of an association with a specific pattern of neuropsychological impairments (frontal, visuospatial) coincides with the brain regions reported to be damaged in anosognosic patients (frontal, right hemisphere, inferoparietal). Mangone et al. (1991) reported similar findings and conclusions in 41 patients with probable AD.

In fact, a growing line of research has demonstrated that underawareness of deficit is associated with impairments on neuropsychological measures thought to be related to frontal lobe functioning. Lopez et al. (1994) examined 181 patients with probable AD and found that AD patients classified as unaware based on their lack of self-report of a memory problem on interview and following a mental status exam had a specific impairment on neuropsychological measures of executive function. Choice Reaction Time and Trailmaking Part B. Michon et al. (1994) also found that a composite executive function score. but not other measures of general intellectual functioning. correlated strongly with the patient-caregiver discrepancy on a memory-functioning questionnaire. In another AD sample. anosognosia was found to be associated with deficits on a maze learning task and a set-shifting task (Starkstein. Sabe. Cuerva. Kuzis. & Leiguarda, 1997). These authors offered several possible relationships between the observed impairments: 1) deficits in procedural learning and set shifting underlie anosognosia or that 2) each of these impairments results independently from frontal lobe dysfunction (Starkstein et al., 1997).

One study suggested that impairments on executive function tasks are not necessarily correlated with anosognosia (Dalla Barba. Parlato. Iavarone. & Boller. 1995). This study contained the important methodological distinction of operationalizing anosognosia by comparing patient self-report with objective memory performance. rather than with caregiver report. Comparing AD patients. depressed patients and controls for their tendency to produce intrusions on a cued recall memory task. these researchers found that regardless of diagnosis. unaware patients made more intrusions. perhaps related to impaired monitoring of the origin of information. Of note. depressed patients overestimated their memory ability more than AD patients did. although AD patients also overestimated compared to controls. However. anosognosia and impairment on most executive function measures. with the exception of verbal fluency. were not correlated in this study. The authors concluded that frontal lobe dysfunction is not a necessary condition for underawareness of deficit. It is also possible that the other executive function measures utilized in this study (modified Wisconsin Card Sort, graphic series, and cognitive estimation) were not assessing those aspects of executive function that might be related to the monitoring processes thought to be involved in metamemory (Dalla Barba et al, 1995).

A functional imaging study utilizing single-photon emission computed tomography has now provided more direct evidence of the dysfunction of frontal brain regions in underaware AD subjects. Starkstein, Vasquez, et al., (1995) utilized patient-caregiver discrepancy on a thirty-item questionnaire about cognitive and behavioral problems. Twelve AD patients who met criteria for impaired awareness of deficits were then matched to AD patients with intact awareness on the basis of age, duration of illness, and general mental status. Examination of neuropsychological test scores showed that the groups performed similarly; nonetheless, the AD patients with impaired awareness showed significantly reduced blood flow in the right inferior and superior dorsal frontal regions. A prior SPECT study, which operationalized awareness using a clinical rating, found a similar pattern of results (Reed, Jagust, & Coulter, 1993).

In essence, questionnaire discrepancy measures have proven a useful index of underawareness of deficit. There is mounting support for the notion that awareness of deficit is not a unitary construct; as AD patients are unaware of deficits in some domains but not in others. Kaszniak and Zak (1996) noted that it remains to be determined whether the apparent selectivity of underawareness of deficit may be due to a measurement artifact. Thus, it is possible that the areas in which patient and relative agree may be those in which AD patients show little deficit (e.g. remote memory). Moreover. questionnaire discrepancy studies have been inconsistent in their findings of a relationship between dementia severity. depression. and underawareness. However. the consensus would appear to be that underawareness is related to impairments on executive tasks and to frontal lobe hypoperfusion on functional imaging studies.

Performance Prediction Studies

Studies requiring AD patients to predict their performance on memory recall tasks have revealed that AD patients consistently overpredict their performance. Schacter. McLachlan. Moscovitch. & Tulving (1986) compared AD patients to patients with memory disorders due to head injury and to ruptured anterior communicating artery aneurysms. Participants studied two 20-item categorized lists and were asked to predict how many of the items they would be able to recall without cues. In one trial. items were presented in a random order. while on another presentation items were blocked by semantic category. Results showed that participants with head injury and with ruptured anterior communicating artery aneurysms were nearly as accurate as controls in their memory performance predictions. AD patients. in contrast. consistently overpredicted their performance compared to controls in both the blocked and random tasks. Importantly. the severity of the memory impairment between the patient groups was fairly equivalent. suggesting that AD patients' overpredictions were not caused by inability to remember they had memory deficits.

In order to explore the possibilities that AD patients simply had a general problem with cognitive estimation or task comprehension. Kaszniak and colleagues (McGlynn & Kaszniak. 1991b; Kaszniak et al., 1993; Kaszniak & Christensen, 1995) compared AD patients' and their relatives' predictions of their own memory performance on various memory tasks with AD patients' and relatives' predictions of each others' performance on the same memory tests. In a series of studies. these researchers found that AD patients over-estimated their own performance while accurately predicting their relatives' performance (McGlynn & Kaszniak. 1991b; Kaszniak. et al., 1993; Kaszniak & Christensen. 1995). Relatives. in contrast. were accurate at predicting both their own and the AD patients' performance. A further finding was that AD patients' predictions indicated that they were as knowledgeable as their relatives about memory functioning in general. ruling out the hypothesis that AD patients' inaccurate predictions were due to a deterioration in their general knowledge about memory function. In other words. AD patients predicted they would perform better on recognition than on recall tests and that their memory would be worse after longer delays. McGlynn and Kaszniak (1991b) interpreted their results to mean that AD patients had disturbances in their memory self-monitoring ability.

A longitudinal study of 21 mild to moderate AD patients and their relatives demonstrated that the extent of patients' overprediction of their performance did not increase as the severity of the illness increased (Kaszniak & Christensen. 1995). In other words. AD patients were able to adjust their self-assessments of memory on performance prediction tasks. but remained consistently underaware (Kaszniak & Christensen. 1995). This study included a revised comparative prediction accuracy index. proposed by

Trosset and Kaszniak (1996), a ratio of ratios which exceeded unity only when the patient exaggerated the self-relative-to-other prediction more than the relative did. Results did not support the possibility of any general patient or relative response biases contributing to AD patients' apparent impaired awareness. In addition, impaired awareness was not correlated with depression as rated by the patient, relative, or clinician.

Interestingly, Kaszniak and Christensen (1995) also administered a patient-caregiver discrepancy questionnaire to these patients longitudinally and found that the patient-caregiver discrepancy on questionnaire increased over the one-year interval. Patients rated their frequency of forgetting similar to their ratings at the baseline assessment; in contrast, relatives rated the patients' forgetting more frequent at one-year compared to baseline. Patients' actual performance did deteriorate over the year, contradicting the suggestion from the performance prediction paradigm that AD patients were able to adjust on a limited basis their self-assessment of memory.

The conflicting results from the two paradigms may have resulted from the fact that the two paradigms tap different aspects of memory performance. Perhaps recall for and awareness of day-to-day memory failures is dissociable from recall for and awareness of memory on experimental tasks. Kaszniak and Zak (1996) hypothesized that the questionnaire method may tap more general memory self-efficacy beliefs, while performance prediction is more closely associated with "on-line" memory processes. The studies by Kaszniak and colleagues, utilizing both the patient-caregiver discrepancy on questionnaire and the performance prediction methods, enabled the examination of the convergent validity of these assessments of awareness. While the researchers obtained convergent support for the interpretation that memory self-monitoring is impaired in AD, they nonetheless found that the questionnaire and performance prediction paradigms shared roughly only 13 % of variance at baseline, suggesting that they tap different components of memory awareness (Kaszniak & Zak).

As reviewed in the systematic questionnaire section above, underawareness of memory deficit in AD patients has been found to be associated with performance on neuropsychological measures thought to rely heavily on frontal lobe functioning in several studies (Lopez, et al., 1994; Michon, et al., 1994; Ott, LaFleche, et al., 1996, but see Dalla Barba et al., 1995). Moreover, AD patients classified as unaware were found to have significantly lower right frontal blood flow than did AD patients with intact awareness who were matched on the basis of age, duration of illness, and general mental status (Starkstein, Vasquez, et al., 1995). Kaszniak and Zak (1996) hypothesized that impaired awareness of deficit in AD patients, caused by poor "on-line" memory self-monitoring, is related to frontal lobe dysfunction. These writers pointed out, however, that because of limitations in the available methodologies, it is not yet possible to entirely rule out the prospect that AD patients are underaware of their memory impairment simply because they have failed to "update" their knowledge concerning the current state of their own as well as others' mental functioning. The problem is that AD patients were required to predict their relatives' memory performance, which should not have shown a significant decline from baseline. It remains possible, then, that AD patients' apparent preservations in general estimation, as indicated by accurate predictions of relatives' memory performance and by questionnaire ratings of caregiver memory problems, were based on knowledge of their relatives' memory functioning acquired prior to the onset of the illness. Therefore, the failure to update mental representations could account for patients' seeming overestimation of their own memory abilities, and their apparently accurate assessments of their relatives' memory ability. Kaszniak and Zak called for future studies in which AD patients are asked to predict memory performance of memory-impaired individuals with whom they have recently been acquainted.

Supporting the hypothesis of a general self-monitoring impairment in AD, one study examined another cognitive ability, speech-monitoring, in AD and PD patients and found that AD patients were less able to monitor their ongoing cognitive performance than were controls (McNamara, Obler, Au, Durso, & Albert, 1992). AD patients, as well as PD patients, were less likely to identify and correct errors in speech output. AD patients corrected only 24 % of expressive speech errors, while controls corrected 72 - 92% of speech errors (McNamara, et al., 1992). The failure to self-correct expressive speech errors was suggested to be related to attentional and frontal dysfunction in these patients (McNamara, et al., 1992), and may be related to impairments in memory self-monitoring previously reported in people with AD.

A study by Correa, Graves, and Costa (1996) more directly examined the relationship between underawareness of memory deficit and memory self-monitoring ability. These researchers examined AD patients, patients with memory impairments who did not meet the clinical criteria for dementia, and elderly controls. They found that AD patients overestimated their memory performance and made more intrusive errors and perseverations during memory tasks than did elderly controls and elderly subjects with circumscribed memory impairment. In addition, AD patients in this study corrected fewer intrusive errors than did controls or memory-impaired subjects, suggesting that they were less able to monitor their memory performance. This study utilized a postdiction task to assess metamemory; participants were asked to evaluate their performance following memory tasks. The authors noted that the postdiction procedure, which enables subjects to make estimates after having had the chance to actually monitor performance, is a more conservative and perhaps more accurate index of memory self-monitoring ability.

The issue of the differential contribution to anosognosia from failures to update mental representations versus impaired memory self-monitoring has not yet been resolved. The feeling-of-knowing method, the final underawareness of deficit paradigm, promises to permit more direct assessment of on-line memory self-monitoring processes.

The Feeling-of-Knowing Paradigm

Originally developed by Hart (1965), the feeling-of-knowing (FOK) paradigm requires participants to rate the likelihood that they will correctly recognize information which they failed to recall on a test of long-term, semantic knowledge (Nelson & Narens, 1980) or of recently learned, episodic material (Schacter, 1983). The FOK assessment may be made by asking individuals to rate their confidence of being able to recognize items from several alternatives using a Likert-type scale and/or to rank order items not recalled by likelihood of subsequent recognition. FOK ratings are then correlated with subsequent recognition performance: individuals with intact FOK would have assigned high FOK ratings to those items that they were able to correctly recognize. It is important to note however, that even normal individuals do not make perfect feeling-of-knowing judgements. Nelson (1996) described a study he did with other colleagues (Nelson, Leonesio, Landwehr, & Narens, 1986) in which individuals were given a general knowledge FOK task, for which questions had been normed in terms of item difficulty, and then made FOK ratings for nonrecalled items. In this study, individuals' subsequent memory performance was better predicted by the base-rate item difficulty than by his/her individual FOK judgement. Nelson and colleagues (described in Nelson, 1996) concluded that people can partially, but not perfectly, reflect on their own semantic knowledge.

In order to examine the relationship between memory ability and metamemory (FOK) processes, researchers have examined FOK ability in patients with various amnestic syndromes. It has been found that, relative to controls, FOK for semantic knowledge may be intact in individuals with severe anterograde amnesia due to various conditions (Shimamura & Squire, 1986) and with dementia due to Huntington's disease (Brandt, 1985). In contrast, Korsakoff's patients show impaired FOK for semantic information (Shimamura & Squire, 1986). Nonetheless, in the Shimamura and Squire study, Korsakoff's patients also performed more poorly than persons with other amnestic syndromes on the semantic knowledge test, leaving open the possibility that their impaired FOK ability was due to impairments in semantic memory and not in metamemory ability. To examine this possibility, Shimamura and Squire conducted a second FOK experiment with Korsakoff's patients, patients with amnesia due to other conditions, as well as with alcoholic and healthy control subjects. Participants were presented with 24 sentences printed individually on cards and were asked to read the sentences aloud and to study them for later recall. On recall, subjects were given the sentence with a noun missing, and were asked to give the missing word. For the FOK phase, participants rated their FOK, on a four-point scale, for the items on which they made errors and then made rank orderings of their FOK for the items. Participants then completed a seven-alternative, forced choice recognition test for all 24 sentences. As in their first experiment, only the Korsakoff's patients showed impaired FOK accuracy relatives to controls, despite the fact that they showed similarly impaired episodic memory as the other amnestic patients (Shimamura & Squire, 1986). Therefore, the FOK impairments in the Korsakoff's group could not be accounted for by differential level of memory performance or by differential difficulty of items not-recalled. Impaired semantic and explicit memory appear to be dissociable from memory self-monitoring performance.

Pappas et al. (Pappas, Sutherland, Weingartner, Vitiello, Martinson, & Putnam, 1992) used the FOK method for both general knowledge questions (following Nelson & Narens, 1980) and for newly learned sentences in their study of 12 individuals with moderate AD and 12 age-matched controls. Participants were given a general knowledge test. Following each item, participants were asked to rate their confidence in their answers using a 6-point scale. Then, subjects were presented with items that they failed to recall and were asked to rate, using a 6-point scale, how likely they would be able to pick the correct item from among several incorrect alternatives (FOK). Next, for items initially answered incorrectly, subjects were asked to pick the correct item from among seven alternatives. Following a break, participants then completed an episodic memory paradigm. Individuals were read 25 sentences slowly, with a brief interval between each sentence sufficient for silent rehearsal. Subjects were given the incomplete sentences, missing the final word, and were instructed to recall the last word and to rate their confidence in their response. For each item they failed to recall, participants made FOK judgements and then completed a six-alternative forced choice recognition test. Therefore, the Pappas and colleagues' paradigm enabled these researchers to examine two aspects of memory self-monitoring: accuracy of judgement about the correctness of initial recall attempts and accuracy of judgements of likelihood of future recognition of information. Not surprisingly, AD patients demonstrated profound deficits in recall from both semantic and episodic memory, compared to control subjects. Nonetheless, AD patients and controls showed similarly accurate judgements about the probability that their initial recall attempts were correct. AD patients were impaired relative to controls, however, in their FOK judgements; they were much less accurate than controls in judging the likelihood of subsequently correctly recognizing answers to general knowledge questions, although their accuracy did exceed chance. On the episodic memory task, there was not sufficient variation in either the AD patients' or the controls' FOK predictions to compute the gamma correlation. The authors suggested that the lack of variation of responses might be due to the lack of repeated items, which diminished the items' range of memory strength. Because moderate AD patients performed above chance on the FOK for general knowledge in this study, the authors suggested that future investigations should examine a broader range of dementia severity, in order to determine if FOK declines with progression of the disease.

The Pappas and colleagues study provided support for the presence of a memory self-monitoring deficit in AD patients, but it indicated that there may be dissociable aspects (retrospective confidence ratings versus prospective ratings of subsequent recognition) of memory self-monitoring in AD patients. Other research has supported the distinction between retrospective ratings of confidence of recall responses and prospective FOK judgements. Nelson, et al. (1990) administered a FOK paradigm to climbers on Mount Everest; they found that the high altitude impaired climbers' FOK judgements, but did not influence the accuracy of their retrospective confidence judgements.

Further investigation has revealed that AD patients may show intact FOK for general semantic knowledge, in contrast to Pappas and colleagues' findings (Lipinska & Bäckman, 1996; Bäckman & Lipinska, 1993). In two studies, AD patients demonstrated equivalent FOK accuracy in comparison to normal older adults, despite showing severely impaired ability to retrieve and recognize general semantic information. Lipinska and Bäckman (1996) further found that there were no differences in FOK accuracy between AD patients with higher versus lower MMSE scores, suggesting that differences in dementia severity may not account for the conflicting results.

Some writers have suggested that metacognitive processes, such as FOK, may rely heavily on functioning of the frontal lobes (e.g. Metcalfe, 1994). Janowsky, Shimamura, and Squire (1989) found that patients with focal frontal lobe damage, but with normal short-term memory, were inaccurate in their FOK judgements for newly learned material when recall was tested after an extended interval. Metcalfe (1994) suggested that FOK performance entails novelty monitoring and control processes commonly ascribed to the frontal lobes. Metcalfe's theoretical novelty monitor/controller was theorized to form a feedback loop with medial temporal structures involved in episodic memory, serving to strengthen memory for novel material. Metcalfe further explained that is likely that novelty monitoring/control is only one of many control and other functions which rely on the frontal lobes. Metcalfe argued that while seemingly simple when compared to other proposed control functions, the ability to judge novelty versus familiarity has a strong impact on "real world memory functioning" (Metcalfe, 1994, p. 155).

Lipinska and Bäckman (1996) noted that different metacognitive tasks, such as FOK for semantic information versus episodic memory test items, may place varying demands on cognitive resources. Semantic information may differ from episodic material in that it is well-integrated into the knowledge base and is thus more easily recalled without the use of self-generated retrieval processes. In Metcalfe's novelty monitoring terms, semantic knowledge is easily identifiable as familiar. In contrast, episodic information is more likely to require the use of the "novelty" monitor. Patients with mild AD would be more likely to exhibit impairments utilizing FOK for episodic information paradigms, while FOK for semantic information may be spared in the early course of the illness.

Summary of underawareness of deficit in AD

In summary, available research suggests an association between frontal lobe dysfunction and impaired awareness of deficit in AD patients. As reviewed by Kaszniak and Zak (1996), impairments in awareness among AD patients do not appear to be related to more global cognitive processes, such as estimation or comprehension ability. Moreover, AD patients appear to retain general knowledge about memory functioning. In contrast, underaware AD patients seem to show deficient memory self-monitoring ability. Research to date has been unable to rule out the possibility that underaware AD patients have simply failed to update their mental representations or beliefs about their personal memory ability, and future studies should take steps to examine this issue.

The variability in the findings of the literature examining the association between disease severity and underawareness may reflect the heterogeneity of the brain regions showing neuropathological changes in AD. The weak association between disease severity and underawareness of deficit may be due to variability in the involvement of the frontal lobes. The frontal lobes may be affected early in the disease course for some patients and not until later in the progression for others. For example, Haxby et al. (1988) studied cerebral glucose metabolism (rCMRglc) in 32 patients with mild to severe dementia and found that the distributions (parietal-premotor) of metabolic reductions in AD patients were variable. These researchers concluded that the apparent variability in parietal-frontal distribution of reduced metabolism was in part related to disease severity and in part to "inter-individual differences in disease expression that were independent of severity" (Haxby et al., 1988, p. 1860).

Kaszniak and Zak (1996) made specific recommendations for future research in this area. First, future studies should continue to utilize quantitative methods such as those reviewed above. Systematic questionnaire and performance prediction studies should examine AD patients' abilities to estimate memory deficits for recent acquaintances with memory impairments. Examination of the selectivity of underawareness should address the similarity of severity of impairment across domains. Kaszniak and Zak further called for more longitudinal designs to assess changes in awareness across the progression of AD. Finally, Kaszniak and Zak pointed to the need for more research into the practical implications of underawareness of deficit, discussed briefly below.

<u>The practical importance of underawareness of deficit in AD: Risky behavior</u>

Although relatively neglected to date in the empirical literature, the practical implications of anosognosia are of special importance to caregivers. It has been pointed out by several writers that anosognosic dementia patients, who deny their memory impairments, may not foresee memory problems or take advantage of appropriate memory aids (Brustrom & Ober, 1998; Kaszniak & Zak, 1996; Kotler-Cope & Camp, 1995). Therefore, underaware AD patients may have an increased tendency to engage in behaviors that are risky or dangerous, given their cognitive and behavioral impairments. For example, AD patients may attempt to use household appliances in an unsafe fashion, to drive, to oversee their own prescription medications, to use power tools, to perform household repairs, or to balance their checkbook and make financial decisions.

Underaware AD patients may also resist family members' attempts to help them, making management of potentially dangerous behaviors especially difficult for caregivers. Finally, others researchers have noted that underaware AD patients may be less willing to consent to treatment (Seltzer, Vasterling, Yoder, & Thompson, 1997). All of the above-mentioned factors may serve to increase the burden on the caregivers of unaware AD patients.

A study by Seltzer et al. (1997) supported the notion that underawareness of memory deficit in AD patients is related to increased caregiver burden. These researchers found that greater underawareness of memory deficit, as measured by patient-caregiver discrepancy on a questionnaire concerning everyday memory functioning, was associated with greater caregiver burden, independent of dementia severity and disease stage. Surprisingly, in this study, perceived caregiver burden was not related to AD patient underawareness of social or self-care impairments. Moreover, in the Seltzer et al. sample, caregiver burden was not related to two common sociodemographic variables, residing with the patient or outside assistance. These authors hypothesized that their lack of findings of association between underawareness of social and self-care abilities might have been related to sample characteristics or psychometric factors.

Several studies examining domains of underawareness in AD have confirmed that awareness for self-care and everyday activities is one of the most profoundly affected areas in anosognosic AD patients, after awareness of memory ability (DeBettignies et al., 1990; Green et al., 1993; Vasterling et al., 1995). DeBettignies et al. (1990) found an association between greater underawareness for independent living tasks and increased caregiver burden. Unfortunately, in order to define patient underawareness, this study utilized patient-caregiver discrepancy on a questionnaire. Therefore, the observed relationship between burden and underawareness in this study may be circular (Mullen, Howard, David, & Levy, 1996). In other words, one cannot rule out the possibility that caregivers who perceived themselves as under a greater amount of stress or burden may be more likely to rate their spouses as less aware. In addition to the impaired self-monitoring ability described above in AD patients, damage to the prefrontal cortex also has been demonstrated to result in deficits in more complex aspects of behaviors, such personality, judgement, and the ability to think ahead and to plan (see Lezak, 1995). These more complex aspects of executive functions are likely to contribute to awareness for self-care ability, in addition to self-monitoring ability.

There are several obstacles to examining the association between awareness of impairment and the occurrence of risky or dangerous behaviors. First, relatives of AD patients are often aware of the potential for risky behavior and rightfully take steps to prevent them. Thus, any strategy that involves soliciting relatives' reports of instances of risky behaviors by AD patients is likely to fail to uncover sufficient variation in these behaviors. Another difficulty in this area of research is identifying what is risky or dangerous for a given individual with AD. Behaviors such as driving may be dangerous for some AD patients and not for others, and the extent of impairment is not always associated with the severity or progression of the disease (e.g. Donnelly & Karlinksy, 1990; Drachman & Swearer, 1993). Despite these difficulties, further research in this area, which has important practical implications, is clearly necessary.

Rationale for the present study

The present study had two main purposes. The first principal goal was to examine the convergent validity of the feeling-of-knowing paradigm as an operationalization of awareness in AD patients. An episodic memory task, modified from Pappas' et al.'s 1992 study, was selected for the paradigm, since an episodic task was believed to be more sensitive to learning and memory deficits in early to moderate AD patients (Lipinska & Bäckman, 1996). Participants were also required to make both retrospective judgements about the accuracy of recall attempts and prospective predictions about future recognition performance. Although past research demonstrated dissociations between retrospective and prospective ratings on semantic knowledge tasks, it was predicted that in the present study AD patients would show relative inaccuracies on both retrospective recall and prospective recognition judgements using an episodic memory task. This pattern of results was expected because both retrospective and prospective judgements were believed to place strong demands on on-line memory monitoring processes in an episodic memory paradigm. In contrast, as discussed by Lipinska and Bäckman (1996), semantic information, consolidated into one's knowledge base, is easier to judge as familiar, without the use of on-line monitoring processes, thus accounting for past findings of preserved retrospective (Pappas et al., 1992) and prospective ratings (Lipinska & Bäckman, 1996) of semantic knowledge in AD patients.

While experimental paradigms like the feeling-of-knowing procedure are believed to tap a certain aspects of awareness (e.g., memory self-monitoring), it is unclear how much association the FOK task has with other methods used to assess awareness, such as caregiver-patient discrepancy on questionnaires or the performance prediction paradigm. In order to examine the issue of impaired awareness in AD patients being due to poor "on-line" memory self-monitoring or to a failure to update one's mental representation about his/her memory ability, the relationship between the FOK task, a self-report memory change measure, and a performance prediction/postdiction task was assessed using principal components analysis. It was hypothesized that the scores on the FOK task and the performance prediction/postdiction task would load on one factor, while the memory self-efficacy measure would remain independent. Such a finding would be consistent with the interpretation that the memory questionnaire approach yields information reflecting more generalized beliefs about one's memory, while the FOK and performance postdiction paradigms are more closely related to on-line memory monitoring.

In support of the distinction between these two aspects of self-awareness of memory functioning, one study found a dissociation between general beliefs about one's memory functioning, which was greatly underestimated by 30 individuals with major depression, and on-line memory monitoring skills which were shown to be intact in the same patients (Kalska, Punamäki, Mäkinen-Pelli, & Saarinen, 1999). According to these investigators, "generalized memory judgements are based on internal representations that may be influenced by negative self-schemata or affective style, whereas on-line memory monitoring is guided by external stimulus conditions and is less under the influence of noncognitive factors" (Kalska et al, 1999, p. 106). Nonetheless, both processes, on-line monitoring and generalized beliefs about one's memory, are involved in global awareness of memory functioning; information gathered from on-line memory monitoring over time is consolidated to form one's global beliefs about one's memory. Thus, in the present study, the factors were hypothesized a priori to be nonorthogonal.

A second purpose of the present study was to examine the relationship between impaired awareness and risky behaviors in AD patients. A caregiver interview, the Risky Behaviors interview, was developed. The RBI asked caregivers to rate riskiness of each behavior for their spouses, as well as the likelihood of the AD patient attempting each behavior. It was hypothesized that metamemory scores from each of the paradigms and caregiver ratings of the likelihood of the patient engaging in risky behaviors would be significantly correlated, with more unaware patients showing greater likelihood to engage in risky activities.

METHOD

Participants

Thirty-two AD patients who met NINCDS-ADRA guidelines for probable AD were examined. Individuals with probable Alzheimer's disease were recruited from a private neurology clinic. The majority of AD patients recruited (22/32) were participating in one of several ongoing clinical trials of investigational medications for the symptomatic treatment of Alzheimer's disease. Seven AD patients were participating in an open-label study of an MAO-inhibitor, while 15 patients were enrolled in double-blind studies. Because the clinical trials were ongoing, the blind concerning medication status had not yet been broken. However, two of the double-blind studies allowed participants to take donepezil, in addition to the double-blind study medication. Eight of the fifteen patients in double-blind studies were also taking donepezil, while seven AD patients in double-blind studies were not taking other medication for AD. Of the remaining AD patients not enrolled in clinical trials, six were taking donepezil and four were not taking any medication for AD. Thus, in most cases, it was not possible to recruit participants who were medication-free.

AD diagnosis for participation in the clinical trials was determined by a neurologist. As part of the clinical trials, laboratory tests (CT scan, chest x-ray, blood chemistry including thyroid and B_{12} levels, urinalysis, electroencephalogram) were performed to rule out other causes of dementia. Patients with histories of: clinically significant medical conditions (hepatic, renal, cardiac, or pulmonary); vascular dementia, normal pressure hydrocephalus, mass lesions; malignant neoplasms within the 2 years prior to trial entry; poorly controlled diabetes mellitus; head injury; other neurological disorders such as Parkinson's disease, Pick's disease, or Huntington's disease; serious psychiatric conditions (major depression, schizophrenia, bipolar disorder, mental retardation); alcohol or substance abuse or dependence within the five years preceding trial entry; seizure disorders; or visual or auditory impairments that interfere with neuropsychological testing were excluded from the clinical trials. Eligible patients were required to be fluent in English. Because caregivers served as control subjects for the study, only AD patients with spouses for caregivers were invited to participate.

Spouses served as control subjects for the study. Inclusion/exclusion criteria for spouses were considerably more liberal. Controls were excluded if they had a history of: clinically diagnosed Alzheimer's disease or other dementing process, stroke, alcohol or substance abuse within the past 2 years, or current major psychiatric illness. Two caregivers were taking an anticonvulsant medication (Dilantin) for seizure disorders. Two caregivers were taking an antidepressant medication, and one caregiver reported taking an anti-anxiety drug on an as needed basis. (Inspection of these caregivers' data revealed that their scores on the dependent variables were consistent with the data for the overall group.)

Potential subjects and their caregivers were contacted by telephone and invited to participate in the study. Thirty-two AD patient-caregiver pairs were recruited for the study. Nine other couples were informed about the study, but declined to participate. This sample size more than doubles the sample (12 AD patients, 12 controls) utilized in the study by Pappas and colleagues (1992), the only one to date to use a FOK procedure with episodic material. Unfortunately, Pappas and colleagues were unable to compute gamma for the FOK in the recognition trial of the episodic task, as both AD patients and controls tended to use a single category when making their prediction for this task. Thus, it was not possible to determine an effect size for the FOK episodic task.

Examiners

In addition to the author, two other examiners performed study assessments. Both of these examiners were upper level undergraduates who received extensive training on the testing procedures. The participant examined (AD patient or caregiver) by the principal investigator was alternated throughout the study.

Measures

To assess dementia severity, the Mini-Mental State Exam was utilized (Folstein, Folstein, & McHugh, 1975). As an additional index of dementia severity, spouses were given a structured clinical interview regarding the patient's functioning on various activities of daily living (Galasko et al, 1997). The Geriatric Depression Scale (GDS; Yesavage et al., 1983) was utilized as a self-report measure of depression. Participants also completed a version of the GDS written in the third person regarding their spouses' current mood/depression. In order to examine risky behaviors, caregivers were administered a novel, structured clinical interview, the Risky Behaviors Caregiver Interview (see Appendix D).

Underawareness of deficits was examined using three different strategies. The feeling-of-knowing paradigm using an episodic memory test was modified from the Pappas et al. 1992 study. The California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987) was used as the memory test for which participants made memory performance predictions and postdictions. The Memory Change scale from the Modified Metamemory in Adulthood scale (Correa, Graves, & Costa, 1996, modified from Dixon & Hultsch, 1984) was used as an assessment of patient-caregiver discrepancy on reports about each other's memory (see Appendix C).

Procedures

The majority of assessment took place in patients' homes, in order to facilitate study participation. Patients and caregivers first read an informed consent form describing the study (see Appendix A). After having all of their questions answered and concerns addressed, consenting patients and caregivers signed the consent forms. Both AD patients and caregivers were required to give informed consent, in order for the couple to be seen for the study.

Next, patients and caregivers were assessed separately and concurrently by different examiners. After providing demographic and medical history information, both patients and caregivers were administered the Mini-Mental State Exam.

The feeling-of-knowing paradigm for an episodic memory task was administered next (modified from Pappas et al. 1992). The modified FOK episodic memory task consisted of 10 sentences with last words that varied in predictability (see Appendix B for a list of items). In order to avoid problems with auditory comprehension, the stimuli were printed individually in a large font on 8.5" X 11" cards, and subjects were required to read each sentence aloud. Items included, "We left early to attend the lecture" (more predictable) and "The quickest way to get there is by bicycle" (less predictable). In addition, in order to increase the variability of confidence ratings during the recall phase, subjects were asked to recall endings for two new sentences, not initially presented during the learning phase.

Complete verbatim instructions for the FOK task can be found in Appendix B. Participants were shown the 12 sentences one at a time and asked to read them aloud and to try to remember them. The examiner presented the sentence cards at uniform intervals, allowing enough time in between each sentence for a brief rehearsal of the item. Following presentation of the items, AD patients were administered the sentence ending recall task. Caregivers, in contrast, completed the sentence ending recall task following a 10-minute delay, during which they completed the Geriatric Depression Scale (Yesavage et al., 1983). The delay was included for caregivers, in an effort to make ease of recall of sentence endings more comparable between the two groups. For the recall task, sentences, minus the final word, were presented one at a time to participants. Participants were asked to recall the final word of each sentence, guessing if necessary. Responses were recorded by the examiner. After attempting to recall each ending, participants were asked to rate their confidence that each answer was correct, using a 6-item scale (1 = extremely uncertain/pure guess, 2 = very uncertain, 3 = somewhat uncertain, 4 = somewhat certain, 5 = very certain, 6 = extremely certain). The confidence ratings were printed on a card placed in front of participants, for reference.

Subjects were then shown each failed item and were asked to indicate their FOK, or their confidence using a four-item scale (1= pure guess, 2 = low, 3= medium, 4 = high) that they would recognize the ending from among five incorrect alternatives endings.

After making a FOK rating for each item, subject were asked to rank order the failed items according to their likelihood of future recognition. In order to accomplish the rankings, participants were shown all of the items rated as having a high FOK and were asked to pick the item for which they had the strongest FOK, the second strongest, and so on. Rankings proceeded in this fashion for all groups of rankings. Although ties were discouraged, they were permitted in a few cases if a participant was unable to distinguish FOK between one or more items. Finally, for the recognition phase, sentences failed during recall were again shown to the participant, one at a time. Under each sentence, the examiner placed 6 possible endings, reading each ending aloud as she put it in place. Seven pre-selected alternatives were available for the examiner to use; one alternative was eliminated, either the one which the subject used during recall or one at random.

Next, AD patients completed the Memory Change scale from the Modified Metamemory in Adulthood (MIA) scale (Correa, Graves, & Costa, 1996, modified from Dixon & Hultsch, 1984; see Appendix C). Instructions (see Appendix C) were read aloud by the examiner, while the participants followed on the written form. In cases where the participant required additional assistance, the experimenter read items aloud to the subject and recorded his or her answers. Participants first rated each MIA item concerning his/her perceptions of his/her own memory functioning. They then completed the Change scale, regarding perceptions of change in his/her spouse's memory ability. Ratings for each item were made on a 5-point Likert scale. The scale is scored so that higher values reflected less perceived memory decline or change. Two items are phrased so that they are asking about perceived improvement in memory ability, ("My memory has improved greatly in the last 10 years.") In order to avoid the confound of combining scores for perceived improvements and declines in memory, these items were scored so perceived improvements received higher scores, i.e. less decline in memory. In contrast to AD patients, caregivers completed that MIA scale during the twenty-minute delay for the modified CVLT.

Participants then completed the memory performance prediction/postdiction paradigm. Participants were administered a modification of the California Verbal Learning Test, in which they were asked to make predictions and postdictions for themselves and for their spouses. The CVLT is a 16-item shopping list learning and memory test. Although the subject is not explicitly informed of it, the list items fall into four semantic categories. Under traditional administration procedures, the items are read aloud to the participant one at a time, and he/she is instructed to remember as many as possible. In a modification of the task for the present study, participants were asked to read the items from printed 3.5 in. X 5 in. cards, in order to avoid problems due to auditory comprehension. Performance predictions and postdictions were made before and after Learning Trials 1 and 5, Tuesday (List B) list, immediate free and cued recalls, delayed free and cued recall, and recognition. For the present study, a five-minute delay was utilized for AD patients, while the traditional 20-minute delay was used for caregivers. The use of the CVLT allowed for an analysis of intrusions, perseverations, and self-corrections, also relevant to on-line memory self-monitoring ability. During the delay, AD patients completed the GDS scales, while caregivers completed the MIA scales.

Caregivers were then administered the Risky Behavior Interview (see Appendix D for items). During the Risky Behavior Interview, caregivers were asked to rate how risky each of 17 potentially risky, dangerous, or unadvisable activities would be for their spouse, using a 7-point Likert scale. For each item, caregivers were also asked to rate how likely their spouse was to attempt the activity, *if precautions were not taken to prevent him or her from doing so.* During Part B of the RBI caregivers were asked to indicate what precautionary measures they had taken in several household domains, including the kitchen, medication use, driving, and finances.

Finally, spouses completed a structured clinical interview regarding the patient's functioning on various activities of daily living (Galasko et al., 1997). This measure was included as an additional index of dementia severity. The entire testing procedure took approximately 2.5 hours.

RESULTS

Demographic and Global Cognitive Performance Variables.

The two groups (AD patients, caregivers) were compared on demographic, mental status scores, and an estimated premorbid full-scale intelligence quotient derived using the Barona index (Barona, Reynolds, & Chastain, 1984). When Levene's statistic for homogeneity of variances indicated that there was no significant difference between the population variances for a given variable, a one-way analysis of variance (ANOVA) was performed. For variables in which homogeneity of variances was not obtained, the Mann-Whitney U, a non-parametric test, was computed. As expected, there was a significant Mental Status effect between groups, with the AD patients demonstrating lower mental status scores ($U(1,62)=129.5$, $p<.0001$). The groups were otherwise equivalent on age, years of education, and Barona estimated premorbid intelligence quotient, as indicated by the lack of significant effect for these variables. Groups were also compared for sex, handedness, and ethnicity using the Pearson Chi-Square statistic. Handedness and ethnicity were comparable between the two groups. However, the groups were not equivalent for sex (Chi-square=16.0, $p<.0001$), with 75% of AD patients being male while only 25% of caregivers were male. In order to rule out the possibility that the sex asymmetry between groups contributed to observed differences on dependent measures, within each group the sexes' performance on each of the dependent variables were compared using a one-way ANOVA or a Mann-Whitney U statistic. Within both the AD patient and the caregiver groups, no significant between sex differences were found for either group. Table 1 summarizes the demographic data for the two groups.

Insert Table 1 about here

In order to rule out the possibility that medication status had differential effects on the dependent measures. AD patients were categorized according to medication use/ clinical trial participation. One-way ANOVAs or Kruskal-Wallis tests. when appropriate. were carried out. No significant between-group differences were found. indicating that medication group had little effect on the dependent measures.

In order to test the hypothesis that AD patients performed more poorly than did caregivers on tests of learning and memory, the two groups' performances on the major CVLT scores and Feeling-of-Knowing recall and recognition scores were compared using one-way ANOVAs or the Mann-Whitney U statistic as appropriate. As expected. relative to caregivers. the AD patients showed significant impairments on all tests of learning and memory. despite having shortened the delay interval. On the modified CVLT. AD patients learned significantly fewer items during the 5 learning trials ($F(1, 61)=217.7$, $P<.0001$. missing data for 1 spouse). recalled fewer of the list items immediately after recall of an interference list (free condition: $F(1,59)=200.5$, $p<.0001$: cued: $U(1,59)=10.0$, $p<.0001$; missing data for 2 AD patients and 1 spouse for both variables), and fewer items after a delay (free condition: $F(1,59)=104.9$, $p<.0001$; cued condition: $U(1,59)=13.5$, $p<.0001$; missing data for 2 AD patients and 1 spouse for both variables). AD patients were also significantly impaired in their ability to correctly recognize the list items ($U(1,59)=280.0$, $p<.007$, missing data for 2 AD patients and 1 spouse). AD patients made significantly more intrusion errors during learning and recall trials ($U(1,59)=209.5$, $p<.0001$, missing data for 2 AD patients and 1 spouse), as well as more false positive recognition errors ($U(1,59)=66.0$, $p<.0001$, missing data for 2 AD patients and 1 spouse). However, caregivers made more perseverations (repetitions of previously provided, correctly recalled items) than did AD patients ($U(1,59)=264.5$, $p<.004$, missing data for 2 AD patients and 1 spouse). Finally, AD patients made less use of the most effective recall strategy, semantic clustering, during learning trials ($U(1,59)=9.5$, $p<.0001$, missing data for 2 AD patients and 1 spouse), and they made fewer spontaneous self-corrections ($U(1,59)=299.5$, $p<.017$, missing data for 2 AD patients and 1 spouse).

The two groups' performances also differed significantly on recall and recognition during the feeling-of-knowing paradigm. AD patients correctly recalled fewer sentence endings than did caregivers ($F(1,62)=13.9$, $p<.0001$) and were also more severely impaired on the recognition of sentence endings ($F(1,61)=22.7$, $p<.0001$, missing data for one AD patient), despite the fact the caregivers were given recall and recognition tasks after a 10-minute distraction filled delay. Table 2 summarizes the groups' performances on tests of learning and memory. Note that recognition data for the FOK task are presented in terms of the proportion of items correct, as the number of items administered during recognition varied depending on the number of items failed during recall.

Insert Table 2 about here

Metamemory Measures.

MIA scale. Patient-caregiver discrepancy on ratings of their own, as well as their spouses' memory, was examined using the MIA Change Scale. A 2 X 2 general linear model approach was taken, with Memory change score as the dependent variable. The between-subjects factor was Rater (AD patients versus Caregivers) and the within-subjects factor was Person Being Rated (AD Patient or Caregiver). The Group by Person Being Rated interaction failed to reach significance ($F(1,60)=1.8$, $p>.18$, missing data for 1AD patient and 1 spouse). There was a significant main effect for Person Being Rated ($F(1,60)=132.9$, $p<.001$). Examination of group means revealed that caregivers' memory was rated by both groups as having declined less than patient's memory (Patient memory change: AD X = 22.9, s.d.=5.0; Caregiver X=14.55, s.d.=5.0; Caregiver memory change: AD X=31.2, s.d.=5.6; Caregiver X=25.0, s.d. = 4.1). There was also a significant effect for Group ($F(1,60)=60.6$, $p<.001$), with AD patients' rating both their own and their caregivers' memory as showing less decline than caregivers reported. Note that the MIA was scaled so that larger values reflected LESS perceived decline in memory ability. Figure 1 illustrates the MIA findings.

Insert Figure 1 about here

<u>Performance Predictions and Postdictions</u>. The accuracy of patients' and caregivers' performance predictions and postdictions on the Modified CVLT were compared using Trosset and Kaszniak's (1996) comparative prediction/postdiction accuracy (CPA). The CPA is a ratio of ratios:

$$\mathrm{CPA}(\epsilon) = \frac{[(ppp + \epsilon)/(pscor + \epsilon)] \div [(ppc + \epsilon)/(cscor + \epsilon)]}{[(cpc + \epsilon)/(cscor + \epsilon)] \div [(cpp + \epsilon)/(pscor + \epsilon)]}$$

where:

ϵ = a constant (=0.1) included in order to avoid undefined values
ppp = patient predicting or postdicting patient
ppc = patient predicting or postdicting caregiver
pscor = patient score
cscor = caregiver score
cpc = caregiver predicting or postdicting caregiver
cpp = caregiver predicting or postdicting patient

Underawareness of deficit is demonstrated by this measure if the AD patient overpredicts his/her own performance relative to the spouse's performance, more than the spouse does. In cases of AD patient underawareness, the CPA exceeds 1.0. As suggested by Trosset and Kaszniak (1996), the natural log of CPAs were taken, as CPAs were positively skewed. As each CPA is based on patient-caregiver pairs, these analyses yielded CPA scores with sample sizes of 26-31. For individual items, a pair was dropped if one or more members of the pair either: 1) did not make a prediction due to examiner error or 2) did not complete the memory item due to dementia severity (see Table 3 for resulting sample sizes). One-sample t-tests were performed to test the null hypothesis that the CPA scores did not differ significantly from zero (as the natural logs of the CPAs were taken). For all CVLT measures with the exception of recognition, the AD patients, as compared to caregivers, showed a greater tendency to overpredict their own performance relative to their spouses' performance (see Table 3). For the recognition trial, the log-transformed CPA computed using the patients' and caregivers' predictions was a negative value, indicating that the raw CPA did not exceed 1.0. Therefore, for the recognition trial, AD patients did not overpredict for themselves relative to their spouses, more than the spouses did.

It has been suggested that the postdiction task is the more conservative index of underawareness, as participants have just had a chance to perform the task when they make performance estimations (Correa, Graves, & Costa, 1996). In the present study, analyses revealed that for the majority of the CVLT measures, the AD patients continued to overestimate their own performances relative to caregivers when making postdictions. The postdiction CPA for Learning Trial 1 failed to reach statistical significance for its difference from zero ($t(1,30) = 1.7$, $p > .098$, missing data for one pair). The recognition trial log-transformed postdiction CPA remained a negative value, indicating that AD patients did not overestimate for themselves relative to the spouses on the recognition trial postdiction. In order to test whether patient and caregivers were able to significantly adjust their estimations of performance, each prediction CPA was subtracted from its respective postdiction CPA, and the resulting values were subjected to t-tests, to test the null hypothesis that the values were not significantly different from zero. In all cases, the CPA change values failed to reach statistical significance, indicating that participants were not able to make significant adjustments to their performance assessments after exposure to the task, as they continued to be underaware relative to spouses. Table 3 summarizes CVLT CPA data for prediction and postdiction tasks.

Insert Table 3 about here

One component of awareness of memory ability is one's general knowledge of how memory functions. In order to examine whether AD patients in the present study had intact general knowledge of memory functioning, the participants' predictions for the AD patients' memory performance across several Modified CVLT trials of interest were examined: Learning Trial 1 versus Learning Trial 5, Immediate Free versus Cued Recall, Immediate Free Recall versus Delayed Free Recall, Delayed Free Recall versus Recognition. Predictions, as opposed to postdictions, were selected for these analyses, as they are made prior to task performance and thus were thought to rely more on participants' preexisting knowledge of how memory functions. For each of these within subject "Memory" factors, a repeated measures general linear model approach was taken, with Rater as a between subjects factor. When patients and caregivers were predicting the patients' performance, no interaction between Rater and Memory factor was found for immediate free versus immediate cued recall tasks ($F(1,59) = .49$, $p > .49$), missing data for 2 AD patients and 1 spouse) or for the immediate – delayed free recall predictions ($F(1,58) = .115$, $p > .73$, missing data for 3 AD patients and 1 spouse). The lack of interaction effects for these comparisons suggests that AD patients and caregivers tended to make similar ratings for the patients' memory performance. There was a main effect for the Memory factor on the immediate free versus immediate cued recall analysis ($F(1, 59) = 20.6$, $p < .001$); inspection of means revealed that both patients and caregivers increased their predictions for the patients when informed that cues would be provided. The main effect for Memory was not significant for the immediate versus delayed free recall analysis ($F(1, 58) = 1.0$, $p > .32$); examination of means indicated that both groups predicted the patient's performance would be similar across a delay.

For the Trial 5 – Trial 1 and delayed recall –recognition comparisons, significant memory factor by rater interactions were discovered (Learning trial factor: $F(1,61) = 29.3$, $p < .001$, missing data for 1 spouse); Recognition/delayed free recall: $F(1,54) = 6.6$, $P < .02$, missing data for 5 AD patients and 3 spouses). For the learning trials, examination of means revealed that AD patients tended to decrease their performance predictions from Trial 1 to Trial 5, while caregivers increased their estimates for the patients. This finding might be related to the fact the AD patients as a group greatly overestimated their Trial 1 performance, but were able to decrease their estimates somewhat across trials. Examination of means for the delayed recall versus recognition tasks indicated that AD patients increased the estimates of their performance to a greater extent than did caregivers, indicating that both groups were aware that memory performance should increased within a recognition format. Although several Rater by Memory factor interactions emerged, the overall pattern of results suggests that AD patients and caregivers' possess similar levels of knowledge about how memory functions over time and across different types of tasks.

Feeling-of-knowing. Following the guidelines of Nelson (1984), for each participant, actual recall performances on the episodic (sentence) memory recall and recognition were compared to retrospective recall confidence ratings and prospective feeling-of-knowing predictions for recognition using the Goodman-Kruskal gamma coefficient. Gamma is a continuous measure, ranging from –1.0 (perfect discordance between ratings and actual scores) to 1.0 (perfect concordance between ratings and scores). For each participant, three gammas were computed: 1) comparing recall performance with retrospective confidence judgments, 2) comparing recognition performance with prospective feeling-of-knowing judgments, 3) and comparing recognition performance with the participant's ranking of his/her likelihood of correctly recognizing the sentence endings. The two sentences not presented during the learning phase were also included in the gamma calculations and were assigned scores of 0 for recall and recognition.

Gammas could not be computed for a given subject if: 1) the recall/recognition scores were all zeros or 2) if the subject used only one category to make all of their ratings. For the retrospective confidence gamma, gammas could not be computed for 8 AD patients and 3 caregivers who failed all recall items. For the FOK gamma, gammas could not be computed for 8 AD patients and 3 caregivers who failed all recognition items, as well as for 1 AD patient and 2 caregivers who used a single category in making FOK ratings. In addition, a FOK gamma was not computed for an additional AD patient who failed to complete the recognition task due to examiner error. Finally, gammas for FOK ratings made using the ranking procedure could not be computed for 8 AD patients and 3 caregivers who failed all recognition items, as well as for the one AD patient who was not administered the recognition trial and one caregiver who stated he could not make the item rankings.

One-way ANOVAs or Mann-Whitney U statistics were then used to compare the groups' gamma coefficients. As predicted, significant group differences were found for all three of the gamma coefficients, with Alzheimer patients showing poorer ability to retrospectively rate the correctness of recall attempts and to prospectively rate the likelihood of future recognition. The Mann-Whitney U statistic was computed, comparing the groups' gammas coefficient for their retrospective confidence judgments about the accuracy of initial recall attempts. AD patients showed poorer retrospective judgment accuracy ($U(1,51)=195.5$, $p<.004$; AD $X=0.48$, s.d.$= 0.65$; Caregiver $X=0.93$, s.d.$=.14$). Groups were similarly compared on their accuracy of their prospective feeling-of-knowing judgments, using one-way ANOVA. AD patients made significantly less accurate prospective judgements about recognition performance ($F(1,47) = 7.484$, $p<.01$; AD $X=-.28$, s.d.$=.64$; Caregiver $X=.26$, s.d.$=.70$). Finally, the groups' rankings of the incorrectly recalled sentences for likelihood of recognition were also compared, using one-way ANOVA. A significant group difference was revealed, with AD patients showing poorer accuracy in their rankings of sentences for likelihood of future recognition ($F(1,49)=12.662$, $p<.002$; AD $X = -.15$, s.d.$=.34$; Caregiver $X=.26$, s.d.$=.49$). Figure 2 depicts the groups' mean gamma coefficients for each of the three ratings.

Insert Figure 2 about here

Because AD patients were significantly impaired relative to caregivers on their recall and recognition performance during the episodic (sentence) memory task, the relationship between severity of memory impairment and accuracy of ratings was examined using a general linear model approach. Recall or recognition scores were entered into an equation, along with Group (AD patient or Caregiver) predicting the gamma score. Recall performance failed to significantly predict retrospective confidence judgment gamma ($F(1,51)=2.4$, $p>.12$). Although a trend was noted, recognition score (proportion correct) did not predict FOK gammas computed using Likert ratings ($f(1,47)=3.2$, $p>.08$). However, Group status also failed to predict FOK gammas computed with the Likert scale ($F(1,47)=1.8$, $p>.18$). Recognition score failed to predict FOK gammas made using ranking procedure ($F(1,49)=.99$, $p>.32$), although Group status was significantly predictive of FOK gammas based on rankings ($F(1,49)=5.8$, $p<.03$). Therefore, AD patients' relatively inaccurate memory ratings were not predicted by the severity of their memory impairment alone.

Principal Components Analysis

In order to explore the relationship between awareness measures obtained using the feeling-of-knowing paradigm (FOK Likert rating), the performance postdiction paradigm (log-transformed CPA postdiction score for delayed free recall), and patient-caregiver discrepancy on the MIA Change questionnaire, a principal components analysis was carried out on the correlation matrix of the variables from the three paradigms. Since observations were based on patient-caregiver pairs for the performance prediction paradigm and for the MIA discrepancy scores, only patients' FOK gammas were included, yielding a total sample size of 32 patient/caregiver observations. For the MIA discrepancy variable, a discrepancy score was calculated by subtracting caregivers' ratings of the change in the patients' memory from patients' ratings of the change in their own memory. In order to facilitate interpretation, subjects' gamma scores were reversed in sign, so that positive values were reflective of greater underawareness, as was the case for the other awareness variables. In order to maximize the analysis sample size, missing values were replaced with group means. It was predicted a priori that, while these three methods of measuring awareness would be interrelated, the feeling-of-knowing and performance postdiction paradigms would be most closely related, as they are both conceptualized as relying upon on-line memory self-monitoring processes. The patient-caregiver discrepancy on questionnaire, in contrast, was hypothesized to remain relatively independent, as this method is conceptualized as depending most heavily on general memory self-efficacy beliefs. Therefore, it was predicted a priori that two, nonorthogonal factors would be found.

The correlation matrix showed that the prospective FOK gammas were not significantly correlated with any of the variables from the other two paradigms. In contrast, the retrospective confidence judgement gamma was significantly correlated with several of the CVLT CPA measures, most notably with several measures of cued recall. The MIA discrepancy variable had significant negative correlations the CVLT Tuesday pre- and postdictions, as well as the Trial 5 postdiction. The significance of the MIA findings is unclear, given that they are in the opposite direction than would be expected. Table 4 contains the correlations between the underawareness variables.

Insert Table 4 about here

The initial extraction was performed using principal components analysis. Components with eigenvalues greater than 1.0 were retained. Six components were extracted. Together the six initial components explained 82.6 % of the total variance. Table 5 contains a listing of the components' eigenvalues, as well as the percentage of variance accounted for by each component.

Insert Table 5 about here

As the components were hypothesized to be interrelated, an oblique rotation was then performed (Direct Oblimin, Delta=0). Table 6 shows the resulting pattern matrix and the component correlation matrix. In partial support of the prediction, the MIA discrepancy score appeared to remain relatively independent from the other two awareness methodologies, having small loadings on five of the components. The MIA discrepancy variable had a strong negative loading on the first component, which also had loadings for the CVLT Trial 5 and Tuesday list variables. The significance of this loading is unclear. Contrary to prediction, the prospective FOK variables loaded on a different component than the performance prediction/postdiction variables. Moreover, the retrospective recall rating loaded on a component with the cued recall CPAs. Inspection of the component correlation matrix revealed that the prospective FOK component largely reflected simple structure, having near-zero correlations with five of the components and a small correlation with the remaining component (r=-.15).

Insert Table 6 about here

Risky behaviors

For each AD patient, scores for Part A of the Risky Behavior Interview (RBI) were computed by summing the products of the Riskiness and Likelihood ratings for each item. The Likert ratings were given the following numerical values: Not at all risky = 0, Slightly risky = 1, Moderately risky = 2, Very risky = 3, Extremely risky = 4; Unlikely = 1, Somewhat likely = 2, Possible = 3, Probable = 4, and Highly probable = 5. Therefore, if a given item was rated as "Not at all" risky and "Highly" probable, the resulting product would be zero and would not contribute to the overall "Riskiness" score. For Part B of the RBI, the total number of items endorsed was computed. Thus, for both Part A and Part B of the interview, higher scores reflect greater propensity to engage in risky behaviors. Thirty-one couples completed the inventory. Scale reliability analysis for the 17-item Part A of the RBI indicated that the scale has good internal consistency reliability (Alpha=.82). Separate reliability analyses were also performed for the 17 riskiness ratings and the 17 likelihood ratings. These reliabilities were also high (Riskiness Alpha = .87, Severity Alpha = .83).

Patients' RBI scores were then correlated with the various indices of underawareness (MIA discrepancy scores, CVLT comparative prediction accuracy index and postdiction accuracy indices, and feeling-of-knowing Goodman-Kruskal gamma coefficients), in order to test the hypothesis that propensity to engage in risky behaviors would be increased when AD patients were less aware of their memory deficits. It was predicted a priori that the Riskiness X Likelihood total score would be negatively correlated with FOK gammas, which are negative when there is less correspondence between one's ratings of his/her memory and actual memory performance, and positively correlated with the MIA patient-caregiver discrepancy score and CVLT CPAs, which are greater when patients are more underaware. In contrast to expectation, the Risky behavior total score was not significantly correlated with any of these measures. Nonetheless, the RBI total score from Part A of the inventory was significantly correlated with the number of safety precautions caregivers reported that they had taken on Part B of the inventory ($r=.59$, $p<.001$, $n=31$). In addition, the RBI total score was correlated with caregivers' ratings of patients' ability to perform activities of daily living ($r=-.49$, $p<.001$, $N=31$). Thus, while higher scores on the RBI were associated with poorer activities of daily living skills and increased need for safety precautions, RBI scores were not significantly correlated with awareness measures.

The predictors of the RBI score were also examined using a stepwise multiple regression approach, in which activities of daily living scores (ADL) were entered first, followed by three measures of underawareness: patients' FOK gammas, the log-transformed CPA index for the CVLT delayed free recall postdictions, and the MIA patient-caregiver discrepancy score. ADL total score was the only variable entered into the equation predicting RBI score (R square=.24, $F(1,18)=5.8$, $p>.02$). Neither FOK gamma, the CVLT delayed free recall postdiction CPA, or the MIA discrepancy score significantly predicted RBI scores (FOK $t=-.45$, $p>0.6$; CVLT delayed free recall postdiction CPA $t=.22$, $p>0.8$; MIA $t=.90$, $p>0.3$). Contrary to prediction, in this sample of AD patients, underawareness of memory impairment did not correlate with risky behavior.

Additional issues.

Percent of anosognosic AD patients. In order to assess the frequency of anosognosia in this AD sample, results from the performance pre- and postdiction paradigm were examined, as the CPA score offers a clear cut point for defining anosognosia. AD patient underawareness is indicated by a CPA score that exceeds unity (or a negative log-transformed score). Using this criteria, between 24.1 and 34.5 percent of the AD sample appeared to be anosognosic, depending on the particular trial examined. Table 7 shows the percent of anosognosic patients on key CVLT trials.

Insert Table 7 about here

Underawareness of Depressive Symptoms. Patient-caregiver discrepancy for reports of depression was examined using the Geriatric Depression scale, which participants used to rate both their own and their spouses' level of depression. Because the number of missing items on the scales did not differ between groups, prorated scores were calculated in cases of missing items. A general linear model approach was taken, with separate analyses conducted for ratings of the patients' and caregivers' depressive symptoms. Rater was entered into an equation predicting patient or caregiver depression scores. For the analysis concerning the patients' depressive symptoms, there was a significant effect for Rater, with AD patients reporting they were less depressed than caregivers had reported ($F(1,61)=24.0$, $p<.001$, AD X= 7.3, s.d. = 5.7, Caregiver X = 14.9, s.d. = 6.5, missing data for 1 spouse). In contrast, for ratings concerning the relatives' level of depressive symptoms, a significant effect for rater was not found ($F(1,59) = .56$, $p >.46$; AD X=5.9, s.d.=6.3, Caregiver X = 7.0, s.d.=4.8, missing data for 3 AD patients). Therefore, AD patients underestimated their own level of depressive symptoms as compared to caregivers' assessment of patients' depression, while the groups agreed on ratings of caregivers' depressive symptoms.

<u>Relationship of dementia severity to awareness measures</u>. Above-described analyses revealed that mental status score did not enter into a regression equation predicting patient-caregiver discrepancy on the MIA change scale and that severity of memory impairment on the recall and recognition tasks from the FOK episodic memory paradigm did not significantly predict FOK gammas. In order to further examine the relationship between dementia severity and underawareness measures, MMSE and ADL scores for the AD patients were correlated with the various measures of underawareness. Results revealed that MMSE was positively correlated with the retrospective confidence judgement gammas ($r=.44$, $p<.04$, $n=24$) and with the FOK gammas made by ranking ($r=.54$, $p<.009$, $n=23$). In other words, AD patients with higher mental status scores

were more accurate at making retrospective and prospective judgements concerning their memory performance. MMSE score was significantly negatively correlated with four variables from the performance pre- and postdiction paradigm, such that patients with lower MMSE scores had higher log-transformed CPAs, indicative of greater underawareness. Dementia severity, as operationalized by caregiver-rated activities of daily living performance, was not significantly correlated with any of the underawareness measures. Table 8 summarizes the correlations between awareness and dementia severity measures.

Insert Table 8 about here

DISCUSSION

The present study examined the convergent validation of three experimental paradigms used in the study of anosognosia for memory impairment in AD patients: 1) the feeling-of-knowing paradigm, 2) the performance pre- and postdiction paradigm, and 3) patient-caregiver discrepancy on a questionnaire measure of perceived memory change. Results derived from each of these three methodologies revealed evidence that as a group AD patients are underaware of their memory impairment, when compared to their demographically similar spouses. Using the Feeling-of-knowing paradigm with an episodic memory task, it was demonstrated that AD patients were less accurate than caregivers at making retrospective judgments about the accuracy of their recall attempts. Furthermore, when asked to predict their future recognition performance, AD patients were also less accurate than their spouses. When participants were asked to make performance predictions and postdictions for themselves and each other during a list learning and memory task (CVLT), similar findings were obtained. AD patients overestimated their own performance relative to their spouses, more than the spouses. Performance prediction-postdiction results also suggested that in general AD patients were unable to significantly adjust their performance estimates following task completion, i.e. during postdictions, as they generally remained underaware. Finally, AD patients' and caregivers' perceptions of decline in their own and their spouses' memory ability were examined. Results showed that AD patients reported less change in their own memory than the memory change reported for AD patients by caregivers. Contrary to past research demonstrating that AD patients and caregivers agreed on ratings concerning the caregivers' memory, in this study, AD patients reported less change in the caregivers' memory than caregivers reported themselves. The findings for each of the three paradigms will be discussed in greater depth below.

The Feeling-Of-Knowing Paradigm.

The present study is the first to date to successfully examine FOK for episodic memory in AD patients. As reviewed previously, prior research using the FOK paradigm with semantic knowledge tasks has shown that FOK ability is unimpaired in patients in the relatively early stages of AD, despite severe recall and recognition impairments (Bäckman & Lipinska, 1993; Lipinska & Bäckman, 1996). A study by Pappas and colleagues (Pappas et al., 1992) found that AD patients showed impaired ability to predict future recognition performance for semantic knowledge items, but were unimpaired in making retrospective recall judgements. Pappas and colleagues also used the FOK paradigm with an episodic memory task. Unfortunately, however, they were not able to compute FOK gamma scores for the task, because participants' ratings did not have sufficient variation. In addition to having a larger sample size, the current study incorporated several procedural changes (e.g. presenting items in written format, ranking FOK for failed items in addition to making the Likert FOK ratings) which likely facilitated computation of gammas. Most importantly, following Shimamura and Squire (1986), participants rank ordered items according to their FOK prior to the recognition trial, enabling FOK gammas to be computed in cases where participants may not have used the full range of the Likert scale. Nonetheless, in the present study, gammas were not able to be computed for several participants whose recall or recognition scores were zero. Although some participants from both groups failed all recall or recognition items, the AD patients were more severely affected (8 AD patients versus 3 caregivers). Future research using this paradigm should attempt to increase AD patients' performance, by providing additional exposures to at least some of the items.

The present finding of impaired retrospective and prospective memory judgements in AD patients is likely attributable to the use of an episodic memory task. As pointed out by Lipinska and Bäckman, (1996), an episodic memory task places greater demands on cognitive resources. Because episodic knowledge is less easily judged as familiar, on-line memory monitoring processes, as well as other self-generated retrieval strategies, are more likely to be attempted. Early in the course of AD, ability to assess semantic memory performance may be relatively intact, while the ability to rate one's episodic memory ability may be impaired (Lipinska & Bäckman, 1996).

The severity of AD patients' recall and recognition impairments was not significantly related to the accuracy of their memory judgements, suggesting that inability to monitor memory performance was not simply an artifact of impaired episodic memory ability in the AD patients. Nonetheless, because the regression coefficient for recognition performance predicting FOK gamma using the Likert rating approached significance, future research should attempt to equate more closely recognition performance between patients and caregivers. In the present study, AD patients' recognition performance (hits) was approximately 22 percent, while caregivers' recognition performance was approximately 50 percent. Future research should aim for approximately 50 percent recognition performance in both groups, either by increasing the length of the delay for caregivers or by providing additional exposures during learning trials for AD patients as described above.

In sum, relative to their non-demented spouses, AD patients showed impaired ability to retrospectively judge the accuracy of their recall during an episodic memory task, as well as impaired ability to prospectively rate the likelihood of correct future recognition. These findings provide strong support for presence of impaired memory monitoring ability in at least some AD patients.

Performance Prediction and Postdiction Paradigm.

Consistent with past research, data from the modified CVLT performance pre- and postdiction paradigm further suggested that, as a group, AD patients overestimated their memory performance, but were relatively accurate in their assessments of their spouses' memory performance. Using a comparative accuracy index devised by Trosset and Kaszniak (1996), between 24 – 35 percent of the AD patients were shown to be underaware on the performance prediction and postdiction paradigm, depending on the variable examined. Thus, in the present study, the incidence of anosognosia in the AD sample was somewhat higher than the 20 percent prevalence rate reported by other researchers (Migliorelli, Teson, et al., 1995). The finding of relative self-overprediction among AD patients was generally consistent for both prediction and postdiction estimates, indicating that AD patients were not able to significantly adjust their memory self-assessments, even immediately upon completion of a memory task. Interestingly, AD patients did not overestimate for themselves relative to caregivers when making predictions and postdictions regarding the CVLT recognition task, despite being impaired relative to caregivers on CVLT recognition performance. One explanation for this finding may be that AD patients were less impaired on this task, relative to the recall items, and closer to the performance of their spouses. Thus, the AD patient who overpredicts or postdicts performance at the same proportion relative to normal expectation would be closer to the actual recognition score.

Analyses of the groups' predictions for how the AD patients would perform across different types of memory tasks on the CVLT revealed the groups to have similar general knowledge of memory functioning. Both groups increased their predictions for the patients in the cued recall condition and recognition conditions over predictions for free recall, although the AD patients predicted a greater benefit for themselves using the recognition format than caregivers predicted for the patients. Surprisingly, neither group predicted that AD patients' performance would significantly decline across a delay, perhaps because of the relatively brief delay intervals. For the Learning Trial 1 versus Learning trial 5 comparison, the groups differed in the predictions for the patients' performance. AD patients' predictions for their learning declined across the trials, while caregivers predictions increased. This finding likely reflects that fact that AD patients greatly overestimated their Trial 1 performance, but were able to adjust their self-estimates for learning to a certain extent, while remaining underaware of the extent of their memory problem. In all, because the two groups seemed to possess similar levels of generalized knowledge about memory functioning, AD patients' relative underawareness does not appear to be related to a deficit in memory knowledge.

AD patients' inability to significantly adjust their self-performance estimates following task completion is consistent with the hypothesis that impaired metamemory in AD patients is due to poor on-line memory self-monitoring. Further evidence for impaired memory self-monitoring ability in can be found by examining other aspects of their CVLT performance. Consistent with the study by Correa et al. (1996), AD patients in this study made dramatically less spontaneous use of the most effective recall strategy, semantic categorization. In addition, AD patients made more intrusions and made fewer self-corrections than did caregivers. The increased intrusive errors and decreased self-corrections of AD patients are suggestive of decreased ability to monitor these aspects of their memory performance. On the other hand, caregivers made more perseverative responses, likely due to the fact that they tended to generate many more items during recall than did AD patients.

Patient-Caregiver Discrepancy on the Modified MIA Change Scale.

On questionnaire ratings of perceived memory change, AD patients rated their memory functioning as having declined less than caregivers' rated the patients' memory decline. In contrast to prior research findings demonstrating that AD patients are relatively accurate at assessing caregivers' memory change, in the present study AD patients also rated their caregivers' memory as having declined less than did caregivers. Therefore, the possibility of a more global impairment in cognitive estimation ability in this patient sample should be considered. One potential explanation for the apparent overestimation by AD patients on assessments of their spouses' memory change may have been related to some level of memory decline by the spouses. The spouses in the present study were somewhat more variable in their mental status scores (24 - 30) than in prior studies (Kaszniak, DiTraglia, & Trosset 1993, McGlynn & Kaszniak, 1991b), although spouses' performance on the modified CVLT appeared to be consistent with the normative performance of their age peers. If patients are rating their spouses based upon "old" mental representations of their functioning, then any caregiver memory decline would result in AD patients overestimating the caregivers' current memory ability in addition to their own. Patients' apparent global overestimation on questionnaires stands in contrast to their performance on the prediction-postdiction paradigm, during which AD patients as a group did not overpredict both for themselves and for their spouses.

Taken together, the above results from three different metamemory paradigms provide support for the hypothesis that AD patients are underaware of their memory impairment. Similar findings were obtained using two different objective approaches, the FOK and performance pre- and postdiction paradigms, which compared patients and caregivers' self-assessment of memory with actual scores on memory tests. On the other hand, questionnaire discrepancy data suggested that AD patients reported less memory change for themselves and their spouses relative to the caregiver's ratings, suggestive of a global tendency to overestimate memory ability, as opposed to self-restricted overestimation. A weakness of the questionnaire approach is that it provides no comparison of the participants' memory ratings to actual performance. The FOK and performance prediction paradigms, in contrast, provide a means of comparing participants' ratings with objective memory scores. The latter two paradigms offer the additional advantage that they require participants to make on-line assessment of their memory functioning, during and following task performance.

The Relationship Between Underawareness of Memory Deficit Paradigms

The three above-described metamemory paradigms have been proposed to vary in the extent to which they address three different components of metamemory ability: 1) general knowledge of memory functioning, 2) beliefs about one's own memory ability, 3) on-line memory self-monitoring. According to Kaszniak and Zak (1996), beliefs about one's own memory ability and general knowledge of memory functioning are primarily assessed by systematic questionnaire and performance prediction methodologies. The feeling-of-knowing paradigm, as well as the performance postdiction procedure, were hypothesized a priori to be the most sensitive to on-line memory self-monitoring ability, as they involve memory assessments made during performance of a memory task.

The present study is the first to utilize each of these methodologies in the same sample of AD patients and caregivers. In order to examine the association between the FOK task, the performance prediction-postdiction paradigm, and the patient-caregiver discrepancy approach, variables from each of the tasks were submitted to a principal components analysis. It was hypothesized a priori that the variables were nonorthogonal, as they are all proposed to assess certain aspects of metamemory ability. However, it was also hypothesized that the FOK and performance postdiction paradigms would be more closely related as they were proposed to assess on-line memory self-monitoring ability.

Results from the principal components analysis can be interpreted as providing partial support for this hypothesis. Although the variables from the two "on-line" paradigms loaded on separate factors, the MIA variable appeared to be relatively independent of both factors, as its loadings for five of the components were negligible. The MIA variable had a strong negative loading on one component, but the significance of this finding is unclear. These results were interpreted as indicating that the MIA discrepancy paradigm is relatively independent from the other two methodologies, perhaps because it reflects more generalized beliefs about one's memory ability.

The hypothesis that the performance postdiction and FOK paradigms would load on a underlying single component, memory self-monitoring ability, was not supported, as the variables from the two paradigms loaded on separate components. Of note, the prospective FOK ratings loaded on one component, while the retrospective recall rating from the episodic memory task loaded on a different component, comprised mainly of CVLT cued recall CPAs. One potential complication with interpretation of this finding pertains to a methodological artifact. In conducting the principal components analysis, in order to maximize sample size, missing values were replaced with group means. Because the majority of AD patients' missing values for the feeling-of-knowing gammas were due to lack of variation in their recall or recognition score (i.e. all items were failed), replacement of these data with the group mean may have made the overall group's performance on the FOK task appear artificially inflated. The number of missing data was slightly greater for the FOK gammas compared to the retrospective gamma (10 AD patients for the Likert FOK gamma and 9 AD patient for the FOK ranked gamma versus

8 AD subjects for the retrospective confidence gamma). Nonetheless, the finding is consistent with previous research. Nelson and colleagues (Nelson, Dunlosky, et al., 1990) demonstrated a dissociation between retrospective and prospective ratings in a sample of high altitude mountain climbers. Nelson (1996) suggested that frontal lobe functioning is critical for prospective FOK ratings. Thus, it appears that memory monitoring processes may vary according to the nature of the task, i.e. assessing future recognition performance versus making retrospective judgements about recall ability. Prospective judgements may rely more heavily on inferential processes, thought to be dependent on the functioning of the frontal lobes. Future studies of metamemory in AD should incorporate neuropsychological measures thought to be sensitive to frontal lobe functioning and/or neuroimaging, in order to investigate which brain regions may mediate various metamemory processes.

The above principal components results were likely hindered by the small analysis sample size, and the current results should be considered preliminary. Future research in this area should include significantly larger sample sizes. Moreover, every attempt should be made to limit missing gamma scores for the FOK paradigm due scores of zero on recall and recognition tasks. Early AD patients' recall and recognition scores would likely improve, at least to a mild degree, if they were provided with multiple learning trials.

The Relationship of Underawareness to Risky Behaviors in AD Patients

Another hypothesis of the present study was that increased underawareness of memory problems would be associated with greater likelihood and severity of risky behaviors among AD patients. A novel caregiver interview, the Risky Behavior Interview, was designed in order to examine this issue. For each of 17 potentially risky or dangerous behaviors, caregivers were asked to rate how dangerous the activity would be for the patients to perform if unsupervised, as well as how likely the patient would be to attempt the activity if unsupervised. In addition, caregivers were also asked to indicate precautionary steps taken or modifications made in order to prevent risky behaviors. Reliability analyses indicated that the interview has good internal consistency. Moreover, caregivers' ratings of increased riskiness on the RBI were associated with increased severity of activity of daily living impairment, suggesting that the inventory showed adequate external validity. Nonetheless, in contrast to expectation, underawareness of memory impairment, as measured by FOK gamma scores, by comparative predictive and postdictive accuracy indices, and by patient-caregiver discrepancy on questionnaire, was not associated with increased RBI scores.

The lack of correlation between risky behaviors and awareness measures did not appear to be due to restricted range of the risky behavior scores. This possibility seems unlikely because the range of variance for the risky behavior score appeared adequate (3 - 42). Moreover, a strong correlation was found between the risky behavior and activities of daily living scores.

One possible explanation for the lack of association between underawareness and risky behaviors in the present study is that caregivers mainly utilize their knowledge of AD patients' functional ability when making assessments of riskiness and propensity to engage in risky behaviors. Because many of the unsupervised activities require a hypothetical judgement, caregivers are likely to rely on functional ability, which is probably more salient to most caregivers than anosognosia for memory impairment. Therefore, caregivers may fail to take into account patients' awareness of memory impairments when making their riskiness assessments. In order to address this possibility, it would be necessary to assess riskiness in a more ecologically valid manner, perhaps through the use of "real-life" assessment techniques and settings designed by occupational therapists.

It is also possible, however, that awareness of memory impairment is not a risk factor for dangerous behaviors among AD patients. Prior research has demonstrated that AD patients' anosognosia varies across domains of cognitive, emotional, and behavioral impairments and that underawareness of memory dysfunction is dissociable from awareness of activities of daily living ability. Thus, a better predictor of risky behaviors among AD patients might be underawareness of ADL impairments. Unfortunately, AD patients' awareness for ADL ability was not assessed in the present investigation.

In their review of anosognosia for memory impairment in AD, Agnew and Morris (1998) offered a model of metamemory impairment which might offer yet another explanation for the lack of association between underawareness for memory impairment and risky behaviors in the present study. These authors suggested that a subset of AD patients with "mnemonic anosognosia" are implicitly aware of memory failures, but fail to encode incidents of memory failures into semantic knowledge regarding their memory ability. Such patients may avoid unadvisable activities because they possess an implicit awareness of memory impairment. Agnew and Morris (1998) pointed out that group studies of metamemory impairments in AD are likely to overlook between-patient variability in the nature of anosognosia.

Implications and Limitations of the Present Study

The present study provided convergent evidence that, as a group, AD patients are underaware of their memory problems. Furthermore, results provided further support for the hypothesized relationship between impaired metamemory in AD and deficient memory monitoring ability. Principal components results confirmed that the MIA discrepancy score, which has been suggested to rely upon generalized beliefs about one's memory ability, was relatively independent from the other two paradigms. However, the factor analysis also demonstrated that the other two paradigms loaded on separate, although oblique factors. One implication of this finding is that on-line memory monitoring ability may vary across different methodologies, particularly for retrospective versus prospective judgments. Nonetheless, it is important to note that the principal components results may have been hampered by the small analysis sample size and should be considered tentative. Because the patient-caregiver discrepancy and performance prediction approaches produce observations based on pairs of participants, future investigations aiming to examine the convergent validity of these measures should take care to include ample participants. As there was some indication that memory monitoring ability may be dissociable according to task, future research using the FOK paradigm should incorporate episodic memory tasks, containing both recall and recognition, as well as retrospective and prospective memory ratings.

Several methodological implications can be derived from the current study. First of all, the FOK paradigm, when used in conjunction with an episodic memory task, proved a valid means of assessing awareness of memory ability in patients with AD. Moreover, the Risky Behaviors Interview, appeared to be a reliable instrument for assessing the likelihood and severity of risky or dangerous behaviors in AD patients and showed a respectable correlation with AD patients' ability to perform activities of daily living. The clinical importance of AD patients' metamemory impairments remains unclear, as the present study failed to uncover evidence that anosognosia is associated with increased riskiness. Future research should investigate whether risky behaviors in AD patients are related to awareness of functional ability. In addition, new, more ecologically valid methods of assessing patient riskiness are needed.

Other limitations of the current study should be noted. AD patients were recruited from ongoing clinical trials of investigational medications for the treatment of AD. Thus, participants in the present investigation may not have been representative of the general population of AD patients. In fact, the majority of the AD patients were male, suggesting that female caregivers may be more prone to seek out new treatments for their spouses. In addition, although they were screened for signs of dementia, the other inclusion/exclusion criteria for the caregivers were somewhat loose. While the liberal criteria for caregivers likely made their data more generalizable to the population of older adults, it should be noted that several caregivers were taking psychotropic medications.

In conclusion, the present study examined the convergent validation of three experimental paradigms for assessing underawareness of memory impairment in AD patients. Each of the three experimental methods, the FOK paradigm, the performance prediction-postdiction paradigm, and the questionnaire-discrepancy method, yielded evidence to suggest that as a group, patients with AD are relatively underaware of the extent of their memory impairment. The study of underawareness in AD has both theoretical and practical importance. Evidence from the present study, as well as from the body of literature concerning anosognosia for memory impairment in AD, indicated that impaired awareness of memory impairment is related to poor memory monitoring ability. The relationship between impaired monitoring ability and frontal lobe dysfunction should be investigated in future studies incorporating comprehensive neuropsychological batteries and/or neuroimaging. These findings are therefore relevant to the study of the neural substrates of consciousness. Although underawareness of memory deficit did not prove to be related to increased risky behaviors in the present sample, prior research has suggested that underawareness of AD patients contributes to caregiver burden. Thus, future research into underawareness of memory deficit in AD patients should take care not to neglect practical implications of the syndrome.

TABLES

Table 1. Subject Characteristics

Variable	AD Patients			Caregivers			
	M	*SD*	Range	*M*	*SD*	Range	
Age	76.6	6.1	58 - 84	74.0	6.0	60 - 84	
Sex (% male)	75	-	-	25	-	-	*
Ethnicity (% white)	94	-	-	94	-	-	
Handedness (% right)	84	-	-	78	-	-	
Education (Yrs.)	13.9	3.4	7 - 20	13.4	2.5	8 - 20	
Barona I.Q. estimate	110.3	8.4	88 – 121	108.5	7.0	93 - 121	
MMSE Score	21.7	4.7	13 - 29	28.0	1.6	24 – 30	*

** p< .001

Table 2. Recall data from the Modified CVLT and Feeling-of-Knowing paradigms

Modified CVLT	**AD Patients**		**Caregivers**		
	M	***SD***	***M***	***SD***	
Trials 1-5	21.2	12.3	61.0	8.7	**
Tuesday List	3.1	2.4	8.2	2.1	**
Immediate Free Recall	2.4	2.5	10.8	2.1	**
Immed. Cued Recall	4.0	3.2	12.7	2.0	**
Delayed Free Recall	2.7	3.6	11.5	3.2	**
Delayed Cued Recall	3.5	3.4	12.6	2.1	**
Clusters	7.0	7.6	46.6	19.5	**
Perseverations	2.6	4.2	5.3	5.2	**
Intrusions	10.3	10.8	2.8	3.6	**
Self-Corrections	2.0	2.4	4.8	5.3	*
Recognition	12.5	4.1	15.0	1.2	**
False Positives	9.6	6.5	0.8	1.2	**

Feeling-of-Knowing	**AD Patients**		**Caregivers**		
	M	***SD***	***M***	***SD***	
Recall	1.7	1.9	3.7	2.3	**
Recognition (proportion correct)	0.2	0.2	0.5	0.3	**

**p < .001
* p < .02

Table 3. Log-transformed CPAs for the Modified CVLT variables

CPA	Prediction			Postdiction		
	n	*M*	*SD*	*n*	*M*	*SD*
Learning Trial 1	31	1.2	2.7*	31	0.7	2.4
Learning Trial 5	31	1.0	1.7*	30	0.7	1.4*
Tuesday List Recall	28	1.2	2.2*	30	0.9	2.3*
Immediate Free Recall	29	1.7	3.0*	30	2.0	2.8*
Immediate Cued Recall	30	1.8	2.9*	28	1.7	2.4*
Long Delay Free Recall	29	1.8	3.5*	30	2.2	3.1*
Long Delay Cued Recall	30	2.1	2.7*	29	2.2	2.6*
Recognition	26	-1.1	1.5*	26	-1.0	1.2*

* T-test of null hypothesis that value = 0; p's < .04

Table 4. Correlation Matrix with One-tailed Significance Levels for the Variables from the Three Underawareness Paradigms

	Recall Gamma r(p)	**FOK-Likert** r(p)	**FOK-Rank** r(p)	**MIA Discrep.** r(p)
Recall Gamma	1.0	.01(.48)	.34(.05)	.25(.12)
FOK (Likert)	.01(.48)	1.0	**.69(.00)**	-.14(.26)
FOK (Rank)	.34(.05)	**.69(.00)**	1.0	-.02(.46)
MIA Discrep.	.25(.12)	-.14(.26)	-.02(.46)	1.0
CVLT Tr. 1 Pre	.00(.50)	.09(.34)	.17(.22)	-.15(.22)
CVLT Tr. 1 Post	.08(.36)	-.08(.37)	.11(.31)	.12(.27)
CVLT Tr. 5 Pre	.16(.22)	-.07(.38)	-.02(.46)	-.30(.05)
CVLT Tr. 5 Post	.21(.17)	-.04(.44)	.06(.39)	**-.43(.01)**
CVLT Tues. Pre	.10(.32)	-.13(.28)	-.07(.38)	**-.51(.00)**
CVLT Tues. Post	.18(.20)	-.06(.39)	.00(.50)	**-.50(.00)**
CVLT Im Free Pre	.34(.05)	-.10(.34)	.11(.30)	-.12(.26)
CVLT Im Free Post	**.43(.02)**	-.06(.40)	.27(.10)	-.17(.18)
CVLT Im Cue Pre	**.49(.01)**	-.04(.43)	.24(.13)	.00(.49)
CVLT Im Cue Post	**.54(.00)**	.03(.45)	.26(.12)	-.10(.30)
CVLT Del Free Pre	-.07(.38)	-.02(.46)	.18(.20)	-.30(.05)
CVLT Del Free Post	-.02(.47)	-.10(.33)	.13(.28)	-.18(.17)
CVLT Del Cue Pre	.29(.09)	-.21(.17)	.02(.46)	-.22(.12)
CVLT Del Cue Post	**.44(.02)**	-.13(.28)	.00(.50)	-.13(.25)
Recognition Pre	-.30(.08)	.01(.49)	-.19(.20)	-.17(.18)
Recognition Post	**-.43(.02)**	.08(.36)	-.33(.07)	-.13(.24)

Table 5. Total variance explained by each component

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	7.167	35.834	35.834	7.167	35.834	35.834	4.129
2	2.838	14.192	50.027	2.838	14.192	50.027	2.368
3	2.069	10.343	60.370	2.069	10.343	60.370	3.955
4	1.672	8.359	68.729	1.672	8.359	68.729	1.887
5	1.455	7.273	76.002	1.455	7.273	76.002	4.911
6	1.315	6.575	82.577	1.315	6.575	82.577	3.399
7	.809	4.043	86.620				
8	.623	3.115	89.735				
9	.465	2.325	92.060				
10	.370	1.848	93.908				
11	.324	1.620	95.528				
12	.251	1.254	96.782				
13	.175	.877	97.659				
14	.142	.711	98.370				
15	.125	.624	98.994				
16	8.173E-02	.409	99.402				
17	5.581E-02	.279	99.681				
18	3.300E-02	.165	99.846				
19	2.133E-02	.107	99.953				
20	9.390E-03	4.695E-02	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 6. Pattern Matrix and Component Correlation Matrix

	1	2	3	4	5	6
Recall Gamma	-.09	-.29	-.06	.12	**.73**	-.12
FOK (Likert)	.06	.16	-.12	**.96**	-.02	.05
FOK (Rank)	-.07	-.12	.14	**.88**	.18	.06
MIA	**-.81**	-.09	-.13	-.14	.19	.20
CVLT Tr. 1 Pre	.19	-.14	.05	.13	-.13	**.88**
CVLT Tr. 1 Post	-.34	-.05	.18	-.02	.16	**.82**
CVLT Tr. 5 Pre	**.50**	.11	-.01	-.05	.18	**.55**
CVLT Tr. 5 Post	**.59**	.01	.23	-.01	.17	.18
CVLT Tues. Pre	**.81**	-.12	.06	-.15	.13	.17
CVLT Tues. Post	**.79**	-.06	-.002	-.08	.35	.01
CVLT Im Free Pre	-.12	.11	**.60**	-.07	**.56**	-.08
CVLT Im Free Post	.08	-.18	**.73**	.02	.39	-.15
CVLT Im Cue Pre	-.04	-.11	.14	.06	**.78**	.13
CVLT Im Cue Post	.20	-.12	.01	.11	**.82**	-.04
CVLT Del Free Pre	.17	.06	**.84**	.06	-.22	.19
CVLT Del Free Post	.10	.02	**.88**	-.04	-.15	.15
CVLT Del Cue Pre	.26	.22	.01	-.15	**.69**	.28
CVLT Del Cue Post	.22	.27	-.08	-.10	**.79**	.20
Recognition Pre	-.03	**.94**	.07	.04	.01	.01
Recognition Post	-.04	**.93**	-.05	.01	-.01	-.15

Extraction Method: Principal components
Rotation Method: Oblimin with Kaiser Normalization
Note: missing values were replaced with group mean. Analysis N=32.

Component Correlation Matrix

Component	1	2	3	4	5	6
1	1.00	.14	.25	-.03	.19	.24
2	.14	1.00	-.05	-.15	-.16	-.01
3	.25	-.05	1.00	.02	.25	.29
4	-.03	-.15	.02	1.00	-.03	-.07
5	.19	-.16	.25	-.03	1.00	.21
6	.24	-.01	.29	-.07	.21	1.00

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Table 7. Percentage of anosognosic patients using the performance pre- and postdiction paradigm

Variable	Prediction	Postdiction
Trial 1	22.6	29.0
Trial 5	25.8	33.3
Immediate Free Recall	27.6	26.7
Delayed Free Recall	24.1	34.5

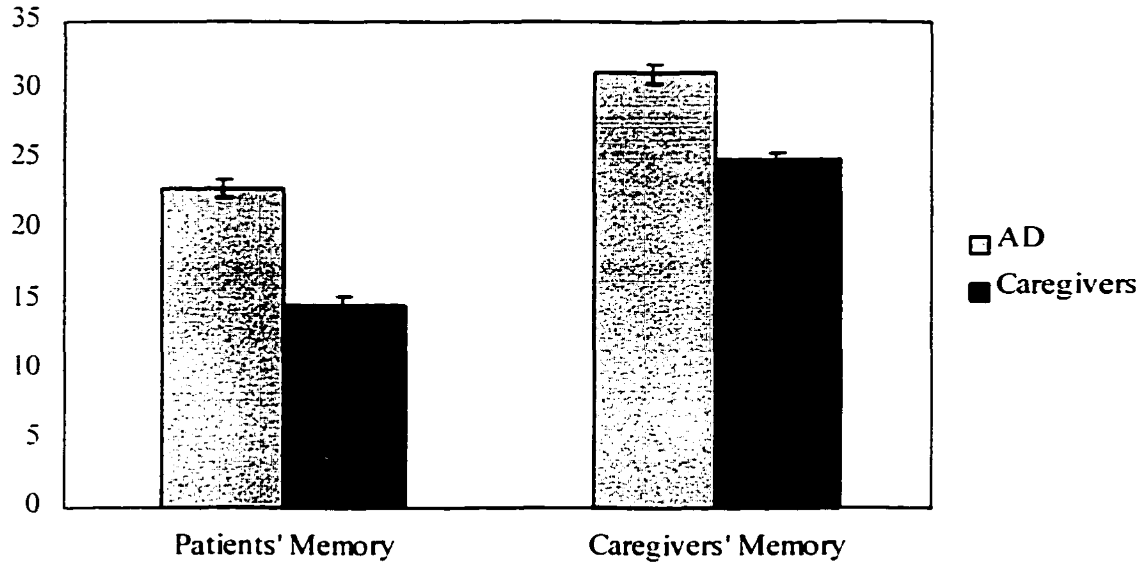
Table 8. Correlations between dementia severity as measured by the MMSE and ADL inventory and awareness indices.

	MMSE (n)	ADL (n)
Retrospective Gamma	**.44** (24)*	.40 (23)
FOK Gamma Likert	.25 (22)	.06 (21)
FOK Gamma Ranked	**.54** (23)**	.25 (22)
Tr. 1 Prediction CPA	-.33 (31)	-.03 (31)
Tr. 1 Postdiction CPA	-.18 (31)	.23 (31)
Tr. 5 Prediction CPA	**-.46** (31)**	-.33 (31)
Tr. 5 Postdiction CPA	**-.45** (30)*	-.25 (30)
Immed. Free Prediction CPA	**-.39** (29)*	.09 (29)
Immed. Free Postdiction CPA	**-.54** (30)**	.01 (30)
Delayed Free Prediction CPA	-.36 (29)	-.002 (29)
Delayed Free Postdiction CPA	-.36 (30)	-.01 (30)

* p<.05
** p<.01

FIGURES

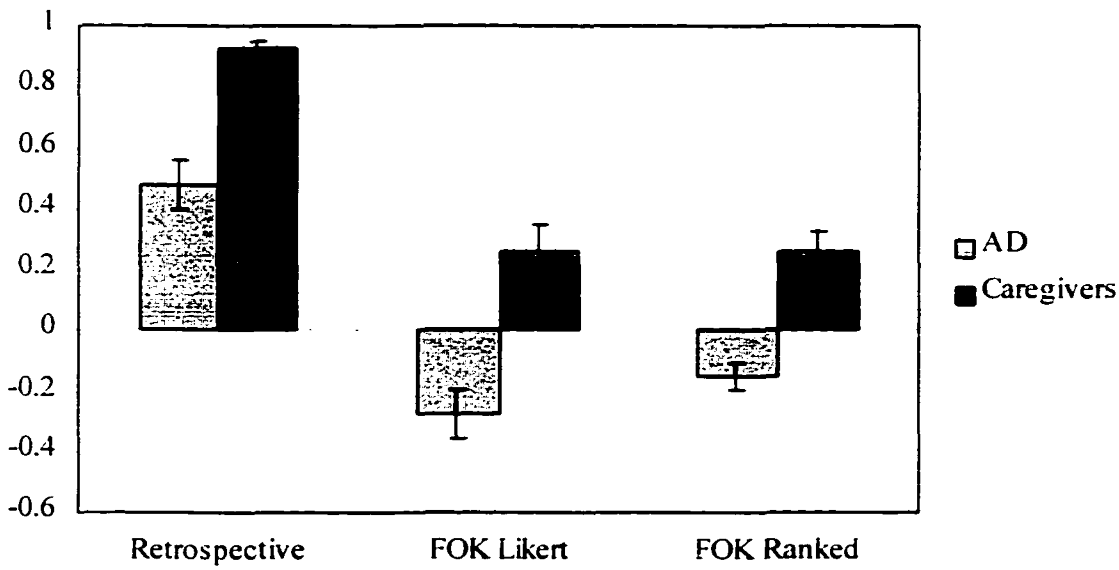
Figure 1. Mean ratings by group of patients' and caregivers' memory change



Note: Error bars represent the standard error of the mean.

The MIA was scaled so that larger values reflect LESS perceived decline in memory ability.

Figure 2. Mean gammas by group



APPENDIX A. PATIENT INFORMATION AND CONSENT FORM

STUDY TITLE: Awareness of Memory Difficulty

PROTOCOL #: 1998-01

PRINCIPAL INVESTIGATORS:
Lisa Duke, M.A.
Alfred Kaszniak, Ph.D.
Department of Psychology
University of Arizona
Tucson, Arizona 85721
(520) 621-7447

INTRODUCTORY STATEMENT

YOU ARE BEING ASKED TO READ THE FOLLOWING MATERIAL TO ENSURE THAT YOU ARE INFORMED OF THE NATURE OF THIS RESEARCH STUDY AND OF HOW YOU WILL PARTICIPATE IN IT, IF YOU CONSENT TO DO SO. SIGNING THIS FORM WILL INDICATE THAT YOU HAVE BEEN SO INFORMED AND THAT YOU GIVE YOUR CONSENT. FEDERAL REGULATIONS REQUIRE WRITTEN INFORMED CONSENT PRIOR TO PARTICIPATION IN THIS RESEARCH STUDY SO THAT YOU KNOW THAT NATURE AND THE RISKS OF YOUR PARTICIPATION AND CAN DECIDE TO PARTICIPATE IN A FREE AND INFORMED MANNER.

PURPOSE OF THE STUDY

We would like to invite you to volunteer to take part in the research project named above. The purpose of the project is to investigate behaviors thought to be associated with the degree of awareness of memory difficulty.

You are being invited to participate because you or your family member is experiencing memory difficulty, and you both will agree to participate in the study. Approximately sixty participants will be enrolled in this study.

If you do not wish to participate in this study, your decision will in no way compromise your right or the right of your family member to services at this medical center, nor will it affect your participation in any other study in which you may be participating.

PROCEDURES TO BE FOLLOWED

If you agree to participate, you will be asked to agree to the following:

1. Answer questions regarding your own memory difficulty and behavior, as well as your family member's memory difficulty and behavior;

2. Allow your family member to answer questions regarding your own memory difficulty or behavior;

3. Take several memory and cognitive functioning tests.

Only one appointment will be required for this study. The total time commitment is expected to be about 2 hours.

RISKS AND BENEFITS

We do not foresee any psychological, mental, or physical harm to be encountered by participation in this study. You may experience some mild fatigue. If so, rest periods will be interspersed to reduce fatigue.

There are no direct benefits to you or to your relative that will occur from your participation in this study. However, additional information regarding the nature, course, and consequences of memory difficulty my be gained and prove helpful to future diagnosis and treatment of other persons. There are no financial costs to you for participation in this study.

CONFIDENTIALITY

In order to ensure confidentiality, your test results will be coded with an identification number, and all personal identification information will be removed. Your data will be stored in a locked room in the Psychology Building at the University of Arizona. Only Lisa Duke, Alfred Kaszniak, and an additional research assistant will have access to the records.

This consent form will be filed in an area with access restricted to the principal investigators, Lisa Duke and Alfred Kaszniak, or to an authorized representative of the Department of Psychology.

VOLUNTARY PARTICIPATION/WITHDRAWAL

I understand that my participation in this study is voluntary. I understand that I may ask questions at any time and that I am free to withdraw from the project at any time without causing bad feelings or affecting my medical care. My participation in this project may be ended by the investigator for reasons that would be explained to me. New information developed during the course of the study which may affect my willingness to continue in this research project will be given to me as it becomes available.

I understand that I do not give up any of my legal rights by signing this form.

CONSENT

I have read and I understand this consent form. My questions have been answered to my satisfaction. I voluntarily consent to participate. I understand that I will be given a signed copy of this consent form to keep.

Participant's signature   Date

I have carefully explained to the participant the nature of the above project. I hereby certify that to the best of my knowledge the person who is signing this form understands clearly the nature, demands, benefits, and risks involved in his/her participation and that his/her signature is legally valid. A medical problem or language barrier has not precluded this understanding.

Witness' signature   Date

APPENDIX B. FEELING-OF-KNOWING PARADIGM (MODIFIED FROM PAPPAS AND COLLEAGUES, 1992).

TASK INSTRUCTIONS

LEARNING PHASE

I AM GOING TO SHOW YOU A LIST OF SENTENCES, ONE AT A TIME. READ EACH SENTENCE ALOUD AND STUDY IT, BECAUSE I AM GOING TO ASK YOU TO REMEMBER THE SENTENCES LATER.

(For AD subjects: Present Trial 1 Learning items only, allowing enough time in between each sentence for a silent rehearsal. For Spouses: Present Trials 1 – 3.)

RECALL PHASE

NOW I AM GOING TO SHOW YOU THE SAME LIST OF SENTENCES AGAIN. THIS TIME, THE LAST WORD OF EACH SENTENCE IS MISSING. PLEASE READ EACH SENTENCE ALOUD AND THEN TELL ME THE MISSING LAST WORD. IF YOU'RE NOT SURE WHAT THE FINAL WORD IS, PLEASE TAKE A GUESS.

SEVERAL OF THE SENTENCES I'LL SHOW YOU NOW ARE ***NEW***. FOR THE NEW SENTENCES, JUST TRY TO ***GUESS*** THE LAST WORD.

ONCE YOU'VE TRIED TO RECALL THE LAST WORD OF EACH SENTENCE, I AM GOING TO ASK YOU HOW CONFIDENT YOU ARE THAT YOUR RESPONSE IS CORRECT. PLEASE RATE YOUR CONFIDENCE IN YOUR ANSWER USING THESE CHOICES. ***Show the ratings, reading each one aloud.***

FOR THE NEW SENTENCES THAT YOU GUESSED THE ENDING FOR, YOU SHOULD RATE YOUR CONFIDENCE AS "1" OR "PURE GUESS".

(Present Recall items. Record subject's response in the blank. If the subject's response is one of the recognition items, cross out that item so that you'll know later not to use that word in the recognition phase. Then, ask the subjects to rate their confidence.)

HOW CONFIDENT ARE YOU THAT ______ IS CORRECT? Point again to the rating sheet. If the subject seems to need help, it is acceptable to read the choices aloud again.

APPENDIX B. FEELING-OF-KNOWING PARADIGM - *Continued*

FEELING OF KNOWING PHASE

NOW I AM GOING TO SHOW YOU ONLY THE SENTENCES THAT YOU MISSED EARLIER. THIS TIME, I WANT YOU TO RATE THE LIKELIHOOD OF YOUR BEING ABLE TO RECOGNIZE THE *CORRECT* MISSING ENDING IF I SHOW IT TO YOU ALONG WITH SOME OTHER *INCORRECT* ENDINGS. WE WILL USE THESE RATINGS. FOR THE NEW SENTENCES THAT YOU DIDN'T SEE THE CORRECT ENDINGS FOR, YOU SHOULD RATE YOUR FEELING OF KNOWING AS A 1 OR "DEFINITELY WON'T RECOGNIZE."

PLEASE READ EACH SENTENCE ALOUD AGAIN. ***Present first incorrect response again.***

WHAT IS YOUR FEELING THAT YOU WOULD KNOW THE CORRECT ENDINGS FOR THIS SENTENCE IF IT WERE SHOWN TO YOU ALONG WITH SEVERAL INCORRECT CHOICES? **PLEASE TRY TO BE AS ACCURATE AS POSSIBLE WHEN MAKING YOUR RATINGS, USING THE WHOLE RANGE OF RESPONSES AS MUCH AS POSSIBLE.**

RANKING:

YOU RATED BOTH OF THESE SENTENCES AS A "6," OR THAT YOU WOULD DEFINITELY RECOGNIZE THE ENDINGS. WHICH SENTENCE DO YOU HAVE A STRONGER FEELING OF KNOWING FOR? WHAT ABOUT THIS ONE – HOW DOES IT COMPARE TO THE OTHERS?

Obtain rankings for each category in this way. Ties are acceptable but try to discourage them whenever possible. Record ranking on response sheet.)

RECOGNITION PHASE

I AM GOING TO SHOW YOU THE SENTENCES YOU MISSED AGAIN, ALONG WITH SOME POSSIBLE ENDINGS. ONE OF THEM IS CORRECT, AND THE OTHERS ARE INCORRECT. READ EACH CHOICE ALOUD AND THEN TELL ME WHICH ONE IS THE CORRECT ENDING FOR THE SENTENCE I SHOWED YOU EARLIER.

APPENDIX B. FEELING-OF-KNOWING PARADIGM – *Continued*

RESPONSE SHEET

____1. The crops were damaged by . **CR:**

Feeling-of-knowing:

drought	heavy rain	birds	early winter
CATTLE	pollution	fire	

____2. Mary was thinking of her . **CR:**

Feeling-of-knowing:

retirement	son	weekend	examination
birthday	CAR	new job	

____3. The missing objects were made of . **CR:**

Feeling-of-knowing:

ceramic	aluminum	wood	CLAY
plastic	leather	rubber	

____4. The garden was full of . **CR:**

Feeling-of-knowing:

MARIGOLDS	vegetables	aphids	workers
flowers	topsoil	fertilizer	

APPENDIX B. FEELING-OF-KNOWING PARADIGM - *Continued*

____5. Some people thought it was too . **CR:**

Feeling-of-knowing:

bright	heavy	sad	silly
dark	SOON	difficult	

____6. The quickest way to get there is by . **CR:**

Feeling-of-knowing:

BICYCLE	walking	car	bus
train	taxi	helicopter	

____7. It was difficult to learn a new . **CR:**

Feeling-of-knowing:

technique	address	SPEECH	operation
game	system	list	

____8. Sarah's favorite food is . **CR:**

Feeling-of-knowing:

nachos	popcorn	chocolate	apple pie
CHIPS	pistachios	broccoli	

APPENDIX B. FEELING-OF-KNOWING PARADIGM - *Continued*

____9. We left early to attend the . **CR:**

Feeling-of-knowing:

concert	LECTURE	auction	ceremony
opera	graduation	play	

____10. The puppy brought its owner a . **CR:**

Feeling-of-knowing:

ball	slipper	newspaper	WALLET
stick	biscuit	leash	

____11. Susan requested that I bring a . **CR:**

Feeling-of-knowing:

picture	BOOK	recipe	test tube
newspaper	costume	photograph	

____12. This museum has a famous collection of . **CR:**

Feeling-of-knowing:

mummies	old books	coins	JEWELRY
vases	tapestries	airplanes	

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES (CORREA, GRAVES, & COSTA, 1996)

Modified MIA Questionnaire (Self)

DIRECTIONS (TO BE READ BY THE EXAMINER):

IN THIS QUESTIONNAIRE WE WOULD LIKE YOU TO TELL US ABOUT YOUR MEMORY AND HOW YOU FEEL ABOUT IT. THERE ARE NO RIGHT OR WRONG ANSWERS TO THESE QUESTIONS BECAUSE PEOPLE ARE DIFFERENT.

EACH QUESTION IS FOLLOWED BY FIVE CHOICES. **DRAW A CIRCLE** AROUND THE LETTER CORRESPONDING TO YOUR CHOICE. MARK **ONLY ONE LETTER** FOR EACH STATEMENT.

SOME OF THE QUESTIONS ASK **YOUR OPINION** ABOUT MEMORY-RELATED STATEMENTS. FOR EXAMPLE: ***(GIVE 1ST SAMPLE QUESTION).***

IN THIS EXAMPLE YOU COULD OF COURSE CHOOSE ANY ONE OF THE ANSWERS. IF YOU AGREE STRONGLY WITH THE STATEMENT YOU WOULD CIRCLE A. IF YOU DISAGREE STRONGLY YOU WOULD CIRCLE LETTER E.

THE B AND D ANSWERS INDICATE LESS STRONG AGREEMENT OR DISAGREEMENT. THE LETTER C ALWAYS GIVES YOU A MIDDLE CHOICE, BUT DON'T USE C UNLESS YOU REALLY CAN'T DECIDE.

SOME OF THE QUESTIONS ASK **HOW OFTEN** YOU DO CERTAIN THINGS THAT MAY BE RELATED TO YOUR MEMORY. FOR EXAMPLE: ***(GIVE 2ND SAMPLE QUESTION)***

AGAIN, YOU COULD CHOOSE ANY ONE OF THE ANSWERS. CHOOSE THE ONE THAT COMES CLOSEST TO WHAT YOU USUALLY DO.

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

SAMPLE QUESTIONS

1. I know if I keep using my memory I'll never lose it.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

2. Do you try to concentrate hard on something you want to remember?

   A. NEVER
   B. RARELY
   C. SOMETIMES
   D. OFTEN
   E. ALWAYS

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

1. I can remember things as well as always.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

2. When you are looking for something you have recently misplaced, do you try to retrace your steps in order to locate it?

   A. NEVER
   B. RARELY
   C. SOMETIMES
   D. OFTEN
   E. ALWAYS

3. I get upset when I cannot remember something.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

4. Do you think about the day's activities at the beginning of the day so you can remember what you are supposed to do?

   A. NEVER
   B. RARELY
   C. SOMETIMES
   D. OFTEN
   E. ALWAYS

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

5. I can't expect to be good at remembering postal codes at my age.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

6. I am less efficient at remembering things now than I used to be.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

7. I get anxious when I am asked to remember something.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

8. I have little control over my memory.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

9. I am just as good at remembering as I ever was.

   A. AGREE STRONGLY
   B. AGREE
   C. UNDECIDED
   D. DISAGREE
   E. DISAGREE STRONGLY

10. When you try to remember people you have met, do you associate names and faces?

    A. NEVER
    B. RARELY
    C. SOMETIMES
    D. OFTEN
    E. ALWAYS

11. I am usually uneasy when I attempt to do a problem that requires me to use my memory.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

12. I misplace things more now than when I was younger.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

13. As long as I exercise my memory it will not decline.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

14. Compared to 10 years ago. I forget many more appointments.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

15. When you have trouble remembering something. do you try to remember something similar in order to help you remember?

A. NEVER
B. RARELY
C. SOMETIMES
D. OFTEN
E. ALWAYS

16. I know if I keep using my memory I will never lose it.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

17. My memory for important events has improved over that last 10 years.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

18. I feel jittery if I have to introduce someone I just met.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

19. It's up to me to keep my remembering abilities from deteriorating.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

20. Do you consciously attempt to reconstruct the day's events in order to remember something?

    A. NEVER
    B. RARELY
    C. SOMETIMES
    D. OFTEN
    E. ALWAYS

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

21. My memory for dates has greatly declined in the last 10 years.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

22. Do you try to relate something you want to remember to something else hoping that this will increase the likelihood of you remembering later?

    A. NEVER
    B. RARELY
    C. SOMETIMES
    D. OFTEN
    E. ALWAYS

23. Even if I work on it, my memory ability will go downhill.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

24. When someone I don't know very well asks me to do something, I get nervous.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

25. Do you try to concentrate hard on something you want to remember?

A. NEVER
B. RARELY
C. SOMETIMES
D. OFTEN
E. ALWAYS

26. No matter how hard a person works on his/her memory. it cannot be improved very much.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

27. My memory for names has greatly declined in the last 10 years.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

28. I get anxious when I have to do something I haven't done for a long time.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

29. If I were to work on my memory, I could improve it.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

30. Do you make mental images or pictures to help you remember?

    A. NEVER
    B. RARELY
    C. SOMETIMES
    D. OFTEN
    E. ALWAYS

31. I get tense and anxious when I feel my memory is not as good as other people's.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

32. My memory has improved greatly in the last 10 years.

    A. AGREE STRONGLY
    B. AGREE
    C. UNDECIDED
    D. DISAGREE
    E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

33. Do you mentally repeat something you are trying to remember?

A. NEVER
B. RARELY
C. SOMETIMES
D. OFTEN
E. ALWAYS

34. I think a good memory comes mostly from working at it.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

MODIFIED MIA QUESTIONNAIRE
RELATIVE/CAREGIVER

DIRECTIONS:

IN THIS QUESTIONNAIRE. WE WOULD LIKE YOU TO TELL US ABOUT THE MEMORY OF YOUR HUSBAND/WIFE. PLEASE TAKE YOUR TIME AND ANSWER EACH OF THESE QUESTIONS TO THE BEST OF YOUR KNOWLEDGE.

EACH QUESTION IS FOLLOWED BY FIVE CHOICES. DRAW A CIRCLE AROUND THE LETTER CORRESPONDING TO YOUR CHOICE. MARK ONLY ONE LETTER FOR EACH STATEMENT. THE QUESTIONS ASK YOUR ***OPINION*** ABOUT MEMORY-RELATED STATEMENTS. FOR EXAMPLE.

THE OLDER HE/SHE GETS THE HARDER IT IS FOR HIM/HER TO REMEMBER.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
D. DISAGREE STRONGLY

IN THIS EXAMPLE. YOU COULD OF COURSE CHOOSE ANY ONE OF THE ANSWERS. IF YOU AGREE STRONGLY WITH THE STATEMENT. YOU WOULD CIRCLE A. IF YOU DISAGREE STRONGLY YOU WOULD CHOOSE E. THE ANSWERS B AND D INDICATE LESS STRONG AGREEMENT OR DISAGREEMENT. THE LETTER C ANSWER GIVES YOU A MIDDLE CHOICE. BUT DON'T USE C UNLESS YOU REALLY CAN'T DECIDE.

KEEP THESE POINTS IN MIND: ANSWER EVERY QUESTION EVEN IF IT DOESN'T SEEM TO APPLY TO HIM/HER VERY WELL.ANSWER AS HONESTLY AS YOU CAN WHAT IS TRUE ABOUT HIM/HER. PLEASE DO NOT MARK SOMETHING BECAUSE IT SEEMS LIKE THE "RIGHT THING TO SAY."

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

1. He/she can remember things as well as always.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

2. Compared to 10 years ago, he/she now forgets many more appointments.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

3. He/she misplaces things more frequently now than when he/she was younger.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

4. He/she is just as good at remembering as he/she ever was.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

5. His/her memory for dates has greatly declined in the last 10 years.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

6. His/her memory has improved greatly in the last 10 years.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

7. His/her memory for important events has improved over the last 10 years.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

8. He/she is less efficient at remembering things now than he/she used to be.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

APPENDIX C. MODIFIED METAMEMORY IN ADULTHOOD SCALES – *Continued*

9. His/her memory for names has declined greatly in the last 10 years.

A. AGREE STRONGLY
B. AGREE
C. UNDECIDED
D. DISAGREE
E. DISAGREE STRONGLY

APPENDIX D. RISKY BEHAVIORS CAREGIVER INTERVIEW

For each of the activities listed below, please indicate how **risky, dangerous, or unadvisable** it would be for your family member to do the activity **without help or supervision**, given the extent of cognitive and/or physical impairment he or she has. Then, please rate the **likelihood** of your family member attempting the activity, *if precautions were not taken to prevent him or her from doing so.*

1. DRIVING ALONE

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

2. DRIVING ACCOMPANIED BY SOMEONE ELSE

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

3. USING THE STOVE, OVEN, OR MICROWAVE

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

4. USING KITCHEN KNIVES OR OTHER UTENSILS

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

5. PREPARING A SNACK OR LIGHT MEAL (SANDWICH, SOUP)

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

6. USING POWER TOOLS OR LAWN/GARDENING EQUIPMENT

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

7. USING HOUSEHOLD APPLIANCES (KITCHEN APPLIANCES, HAIRDRYER, ELECTRIC RAZOR)

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

8. TAKING PRESCRIPTION MEDICATIONS

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

APPENDIX D. RISKY BEHAVIORS CAREGIVER INTERVIEW – *Continued*

9. WALKING AROUND FAMILIAR STREETS UNACCOMPANIED

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

10. WALKING AROUND UNFAMILIAR STREETS UNACCOMPANIED

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

11. PERFORMING HOUSEHOLD REPAIRS

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

12. MANAGING FINANCES (PAYING BILLS, BALANCING CHECKBOOK)

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

13. MAKING FINANCIAL DECISIONS (SIGNIFICANT PURCHASES)

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

14. SMOKING CIGARETTES, PIPES, OR CIGARS

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

15. SELF-CARE ACTIVITIES LIKE BATHING (GETTING INTO THE TUB) OR TOILETING

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

16. NEGOTIATING STAIRS

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

17. USING CLEANING SUPPLIES OR OTHER HOUSEHOLD CHEMICALS

Riskiness:	Not at all risky	Slightly risky	Moderately risky	Very risky	Extremely risky
Likelihood:	Unlikely	Somewhat Likely	Possible	Probable	Highly probable

APPENDIX D. RISKY BEHAVIORS CAREGIVER INTERVIEW – *Continued*

Which of the following steps or precautions have you taken in order to ensure the patient's safety at home?

Kitchen

☐ caregiver cooks because patient is unable to cook
☐ stove turned off or cord unplugged at night
☐ protective covers on stove knobs or knobs removed
☐ matches or lighters put away
☐ knives locked up or removed from home
☐ potentially poisonous cleaners locked up

Bathroom

☐ water temperature turned down to prevent burns
☐ lock removed from inside bathroom door

Medications

☐ medication monitoring
☐ locking up medications

General Household

☐ new locks on *exterior* doors added to prevent wandering
☐ new locks on *interior* doors added to prevent access to dangerous areas
☐ locks on bedroom door removed to prevent patient from locking self in
☐ sharp objects/tools (razor blades, power tools, scissors, pins, needles, pencils, letter openers, breakables) removed
☐ guns removed

Driving

☐ driving restricted to daytime or only when accompanied
☐ car keys hidden
☐ car disabled or removed from premises

Grooming

☐ shaving supervised
☐ caregiver shaves patient

Social
☐ social contacts minimized
☐ friends informed of diagnosis

Financial
☐ access to bank accounts or credit cards supervised

REFERENCES

Agnew, S.K. & Morris, R.G. (1998). The heterogeneity of anosognosia for memory impairment in Alzheimer's disease: A review of the literature and a proposed model. Aging and Mental Health, 2, 7 – 19.

American Psychiatric Association. (1994). Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. Washington, DC: American Psychiatric Press.

Anderson, S.W. & Tranel, D. (1989). Awareness of disease states following cerebral infarction, dementia, and head trauma: Standardized assessment. The Clinical Neuropsychologist, 3, 327-339.

Babinski, J. (1914). Contribution a l'etude des troubles mentaux dans l'hemiplegie organique cerebral (Anosognosie). [Contribution to the study of mental disturbance in organic cerebral hemiplegia (Anosognosia).] Revue Neurologique, 27, 845 – 848.

Bäckman, L. & Lipinska, B. (1993). Monitoring of general knowledge: Evidence for preseveration in early Alzheimer's disease. Neuropsychologia, 31, 335-345.

Barona, A., Reynolds, C.R., & Chastain, R. (1984). A demographically based index of premorbid intelligence for the WAIS-R. Journal of Consulting and Clinical Psychology, 52, 885- 887.

Bisiach, E. & Geminiani, G. (1991). Anosognosia related to hemiplegia and hemianopia. In G. P. Prigatano & D.L. Schacter (Eds)., Awareness of Deficits after Brain Injury: Clinical and Theoretical Issues (pp. 17 – 39). New York: Oxford University Press.

Bondareff, W., Mountjoy, C.Q., & Roth, M. (1982). Loss of neurons of origin of the adrenergic projection to cerebral cortex (nucleus locus ceruleus) in senile dementia .Neurology, 32, 164 - 167.

Bondi, M.W., Salmon, D.P., and Kaszniak, A.W. (1996). The neuropsychology of dementia. In I. Grant and K.M. Adams (Eds.), Neuropsychological Assessment of Neuropsychiatric Disorders, Second Edition (pp. 164 - 199). New York: Oxford

University Press.

Brandt, J. (1985). Access to knowledge in dementia of Huntington's disease. Developmental Neuropsychology, 1, 335 – 348.

Brustrom, J.E. & Ober, B.A. (1998). Predictors of perceived memory impairment: Do they differ in Alzheimer's disease versus normal aging? Journal of Clinical and Experimental Neuropsychology, 20, 402 – 412.

Correa, D.D., Graves, R.E., & Costa, L. (1996). Awareness of memory deficit in Alzheimer's patients and memory-impaired older adults. Aging, Neuropsychology, and Cognition, 3, 215-228.

Cummings, J.L. & Benson, D.F. (1992). Dementia: A Clinical Approach (Second Edition). Boston: Butterworth-Heineman.

Dalla Barba, G., Parlato, V., Iavarone, A., & Boller, F. (1995). Anosognosia, intrusions, and 'frontal' functions in Alzheimer's disease and depression. Neuropsychologia, 33, 247 – 259.

DeBettignies, B.H., Mahurin, R.K., Pirozzolo, F.J. (1990). Insight for impairment in independent living skills in Alzheimer's disease and multi-infarct dementia. Journal of Clinical and Experimental Neuropsychology, 12, 355 - 363.

Delis, D.C., Kramer, J.H., Kaplan, E., & Ober, B.A. (1987). The California Verbal Learning Test. New York: Psychological Corporation.

Dixon, R.A. & Hultsch, D.F. (1984). Structure and development of metamemory in adulthood. Journal of Gerontology, 38, 682 – 688.

Donnelly, R.E. & Karlinsky, H. (1990). The impact of Alzheimer's disease on driving ability: A Review. Journal of Geriatric Psychiatry and Neurology, 3, 67 – 72.

Drachman, D.A. & Swearer, J.M. (1993). Driving and Alzheimer's disease: The risk of crashes. Neurology, 43, 2448 – 2456.

Feher, E.P., Larrabee, G.J., Sudilovsky, A., & Crook, T.H. (1994). Memory self-report in Alzheimer's disease and age-associated memory impairment. Journal of Geriatric Psychiatry and Neurology, 7, 58 – 65.

Feher, E.P., Mahurin, R.K., Inbody, S.B., Crook, T.H., & Pirozzolo, F.J. (1991). Anosognosia in Alzheimer's disease. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 4, 136 – 146.

Flavell, J.H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, 34, 906 – 911.

Folstein, M.F., Folstein, S.E., McHugh, P.R. (1975). "Mini-mental state" – a practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research, 12, 189- 198.

Frederiks, J.A.M. (1985). The neurology of aging and dementia. In J.A.M. Frederiks (Ed.) Handbook of Clinical Neurology, Volume 2 (pp. 199 – 219). Amsterdam: Elsevier.

Galasko, D., Bennett, D., Sano, M., Ernesto, C., Thomas, R., Grundman, M., Ferris, S., & Alzheimer's disease cooperative Study (1997). An inventory to assess activities of daily living in clinical trials for Alzheimer's disease. Alzheimer Disease and Associated Disorders, 11 (Suppl. 2), S33 - S39.

Gilley, David W. (1993). Behavioral and affective disturbances in Alzheimer's disease. In R. Parks, R. Zec, and R. Wilson (Eds.), Neuropsychology of Alzheimer's Disease and Other Dementias (pp. 112 - 137). New York: Oxford University Press.

Green, J., Goldstein, F.C., Sirockman, B.E., & Green, R.C. (1993). Variable awareness of deficits in Alzheimer's disease. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 6, 159 - 165.

Hameroff, S.R., Kaszniak, A.W., & Scott, A.C. (Eds.) (1996). Toward a Science of Consciousness. Cambridge, MA: Massachusetts Institute Of Technology Press.

Hart, J.T. (1965). Memory and the feeling-of-knowing experience. Journal of Educational Psychology, 56, 208 – 216.

Haxby, J.V., Grady, C.L., Koss, E., Horwitz, B., Schapiro, M., Friedland, R.P., & Rapoport, S.I. (1988). Heterogeneous anterior-posterior metabolic patterns in dementia of the Alzheimer type. Neurology, 38, 1853 – 1863.

Hermann, D.J. (1982). Know the memory: The use of questionnaires to assess and study memory. Psychological Bulletin, 92, 434 – 452.

Hertzog, C. & Dixon, R.A. (1994). Metacognitive development in adulthood and old age. In J. Metcalfe & A.P. Shimamura (Eds.), Metacognition: Knowing about Knowing pp. 227 – 251). Cambridge, MA: Massachusetts Institute Of Technology Press.

Hyman, B.T., Arriagada, P.V., Van Hoesen, G.W., and Damasio, A.R. (1993). Memory impairment in Alzheimer's disease: An anatomical perspective. In R.W. Parks, R.F. Zec, and R.S. Wilson (Eds.) Neuropsychology of Alzheimer's Disease and Other Dementias (pp. 138 - 152). New York: Oxford University Press.

Janowsky, J.S., Shimamura, A.P., Squire, L.R. (1989). Memory and metamemory: Comparisons between patients with frontal lobe lesions and amnesic patients. Psychobiology, 17, 3 – 11.

Kalska, H., Punamäki, R.L., Mäkinen-Pelli, T., & Saarinen., M. (1999). Memory and metamemory functioning among depressed patients. .Applied Neuropsychology, 6, 96-107.

Kaszniak, A.W. & Christensen, G.D. (1995). One-year longitudinal changes in the metamemory impairment of Alzheimer's disease (abstract). Journal of the International Neuropsychological Society, 1, 145.

Kaszniak, A.W., DiTraglia, G. & Trosset, M.W. (1993). Self-awareness of cognitive deficit in patients with probable Alzheimer's disease (abstract). The Journal of Clinical and Experimental Neuropsychology, 15, 30.

Kaszniak, A. W. & Zak, M. G. (1996). On the neuropsychology of metamemory: Contributions from the study of amnesia and dementia. Learning and Individual Differences, 8, 355-381.

Katzman, R. (1986). Alzheimer's disease. The New England Journal of

Medicine, 314: 964 - 973.

Khachaturian, Z.S. (1985). Diagnosis of Alzheimer's disease. Archives of Neurology, 42, 1097 - 1105.

Kral, V.A. (1983). The relationship between senile dementia (Alzheimer type) and depression. Canadian Journal of Psychiatry, 28, 304 – 306.

Kotler-Cope, S. & Camp, C.J. (1995). Anosognosia in Alzheimer disease. Alzheimer Disease and Associated Disorders, 9, 52 – 56.

LaRue, A. (1992). Aging and Neuropsychological Assessment. New York: Plenum Press.

Lezak, M.D. (1995). Neuropsychological Assessment (Third Edition). New York: Oxford University Press.

Lipinska, B. & Bäckman, L. (1996). Feeling-of-knowing in fact retrieval: Further evidence for preservation in early Alzheimer's disease. Journal of the International Neuropsychological Society, 2, 350-358.

Lopez, O.L., Becker, J.T., Somsak, D., Dew, M.A., & DeKosky, S.T. (1994). Awareness of cognitive deficits and anosognosia in probable Alzheimer's disease. European Neurology, 34, 277 – 282.

Mangone, C.A., Hier, D.B., Gorelick, P.B., Ganellen, R.J., Langenberg, P., Boarman, R., & Dollear, W.C. (1991). Impaired insight in Alzheimer's disease. Journal of Geriatric Psychiatry and Neurology, 4, 189 – 193.

McGlone, J., Gupta, S., Humphrey, D., Oppenheimer, S., Mirsen, T., & Evans, D.R. (1990). Screening for early dementia using memory complaints from patients and caregivers. Archives of Neurology, 47, 1189 – 1193.

McGlynn, S.M. & Kaszniak, A.W. (1991a). Unawareness of deficits in dementia and schizophrenia. In G.P. Prigatano and D.L. Schacter (Eds.) Awareness of Deficit After Brain Injury: Clinical and Theoretical Issues (pp. 85 – 110). New York: Oxford

University Press.

McGlynn, S.M. & Kaszniak, A.W. (1991b). When metacognition fails: Impaired awareness of deficit in Alzheimer's disease. Journal of Cognitive Neuroscience, 3, 183 – 189.

McGlynn, S.M. & Schacter, D.L. (1989). Unawareness of deficits in neuropsychological syndromes. Journal of Clinical and Experimental Neuropsychology, 11, 143 – 205.

McGlynn, S.M., Schacter, D.L., & Glisky, E. L. (1989). Unawareness of deficits in organic amnesia (abstract). Journal of Clinical and Experimental Neuropsychology, 11, 50.

McKhann, G., Drachman, D.,, Folstein, M., Katzmann, R., Price, D., and Stadlan, E.M. (1984). Neurology, 34, 939-944.

McNamara, P., Obler, L.K., Au, R., Durso, R., & Albert, M.L. (1992). Speech monitoring skills in Alzheimer's disease, Parkinson's disease, and normal aging. Brain and Language, 42, 38 - 51.

Metcalfe, J. (1994). A computational modeling approach to novelty monitoring, metacognition, and frontal lobe dysfunction. In J. Metcalfe & A.P. Shimamura (Eds.), Metacognition: Knowing about Knowing (pp. 137 - 156). Cambridge, MA: Massachusetts Institute Of Technology Press.

Michon, A., Deweer, B., Pillon, B., Agid, Y., & DuBois, B. (1994). Relation of anosognosia to frontal lobe dysfunction in Alzheimer's disease. Journal of Neurology, Neurosurgery, and Psychiatry, 57, 805 – 809.

Migliorelli, R., Petracca, G.,Teson, A., Sabe, L., Leiguarda, R., & Starkstein, S.E. (1995). Neuropsychiatric and neuropsychological correlates of delusions in Alzheimer's disease. Psychological Medicine, 25, 505 – 513.

Migliorelli, R., Teson, A., Sabe, L., Petracca, G., Petracchi, M., Leiguarda, R., & Starkstein, S.E. (1995). Anosognosia in Alzheimer's disease: A study of associated factors. The Journal of Neuropsychiatry and Clinical Neurosciences, 7, 338 – 344.

Migliorelli, R., Teson, A., Sabe, L., Petracca, G., Leiguarda, R., & Starkstein, S.E. (1995). Prevalence and correlates of dysthymia and major depression among patients with Alzheimer's disease. American Journal of Psychiatry, 152, 37 – 44.

Mullen, R., Howard, R. David, A., & Levy, R. (1996). Insight in Alzheimer's disease. International Journal of Geriatric Psychiatry, 11, 645 – 651.

Nelson, T.O. (1984). A comparison of current measures of the accuracy of feeling-of-knowing predictions. Psychological Bulletin, 95, 109 – 133.

Nelson, T.O. (1996). Consciousness and metacognition. American Psychologist, 51, 102 – 116.

Nelson, T.O., Dunlosky, J., White, D.M., Steinberg, J., Townes, B.D., & Anderson, D. (1990). Cognition and metacognition at extreme altitude on Mount Everest. Journal of Experimental Psychology: General, 119, 367 – 374.

Nelson, T.O., Leonesio, R.J., Landwehr, R.S., & Narens, L. (1986). A comparison of three predictors of an individual's memory performance: The individual's feeling-of-knowing versus base-rate item difficulty. Journal of Experimental Psychology: Learning, Memory, and Cognition, 12, 279 – 287.

Nelson, T.O. & Narens, L. (1980). Norms of 300 general-information questions: accuracy of recall and feeling-of-knowing ratings. Journal of Verbal Learning and Verbal Behavior, 19, 338- 368.

Newman, J. (1997a). Putting the puzzle together. Part I: Towards a general theory of the neural correlates of consciousness. Journal of Consciousness Studies, 4, 47 - 66.

Newman, J. (1997b). Putting the puzzle together. Part I: Towards a general theory of the neural correlates of consciousness. Journal of Consciousness Studies, 4, 100 - 121.

Ott, B.R., Lafleche, G., Whelihan, W.M., Buongiorno, G.W., Albert, M.S., & Fogel, B.S. (1996). Impaired awareness of deficits in Alzheimer disease. Alzheimer Disease and Associated Disorders, 10, 68 – 76.

Ott, B.R., Noto, R.B., & Fogel, B.S. (1996). Apathy and loss of insight in Alzheimer's disease: A SPECT imaging study. Journal of Neuropsychiatry and Clinical Neurosciences, 8, 41 - 46.

Pappas, B.A., Sunderland, T., Weingartner, H.M., Vitiello, B., & Putnam, K. (1992). Alzheimer's disease and feeling-of-knowing for knowledge and episodic memory. Journal of Gerontology: Psychological Sciences, 47, P159 – 164.

Pearson, J.L., Teri, L., Reifler, B.V., & Raskind, M.A. (1989). Functional status and cognitive impairment in Alzheimer's patients with and without depression. Journal of the American Geriatrics Society, 37, 1117 – 1121.

Ramanchandran, V.S. (1995). Anosognosia in parietal lobe syndrome. Consciousness and Cognition, 4, 22 – 51.

Reed, B.R., Jagust, W.J., & Coulter, L. (1993). Anosognosia in Alzheimer's disease: Relationships to depression, cognitive function, and cerebral perfusion. Journal of Clinical and Experimental neuropsychology, 15, 231 – 244.

Reisberg, B., Gordon, B., McCarthy, M., Ferris, S.H., & deLeon, M.J. (1985). Insight and denial accompanying progressive cognitive decline in normal aging and Alzheimer's disease. In B. Stanley (Ed.), Geriatric Psychiatry: Ethical and Legal Issues (pp. 19 – 39). Washington, DC: American Psychiatric Press.

Schacter, D.L. (1983). Feeling of knowing in episodic memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 9, 39 –54.

Schacter, D.L. (1991). Unawareness of deficit and unawareness of knowledge in patients with memory disorder. In G.P. Prigatano & D.L. Schacter (Eds.), Awareness of Deficit after Brain Injury: Clinical and Theoretical Issues (pp. 127 – 151). New York: Oxford University Press.

Schacter, D.L., McLachlan, D.R., Moscovitch, M., & Tulving, E. (1986). Monitoring of recall performance by memory-disordered patients (abstract). The Journal of Clinical and Experimental Neuropsychology, 8, 130.

Schneck, M.K., Reisberg, B., & Ferris, S.H. (1982). An overview of current concepts of Alzheimer's disease. American Journal of Psychiatry, 139, 165 – 173.

Seltzer, B., Vasterling, J.J., Hale, M.A., & Khurana, R. (1995). Unawareness of memory deficit in Alzheimer's disease: relation to mood and other disease variables. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 8, 176 – 181.

Seltzer, B., Vasterling, J.J., Yoder, J., & Thompson, K.A. (1997). Awareness of deficit in Alzheimer's disease: Relation to caregiver burden. The Gerontologist, 37, 20 – 24.

Sevush, S. & Leve, N. (1993). Denial of memory deficit in Alzheimer's disease. American Journal of Psychiatry, 150, 748 – 751.

Shimamura, A.P. & Squire, L. R.(1986). Memory and metamemory: A study of the feeling-of-knowing phenomenon in amnesic patients. Journal of Experimental Psychology: Learning, Memory, and Cognition, 12, 452 – 460.

Starkstein, S.E., Migliorelli, R., Teson, A., Petracca, G., Chemerinsky, E., Manes, F., & Leiguarda, R. (1995). Prevalence and clinical correlates of pathological affective display in Alzheimer's disease. Journal of Neurology, Neurosurgery, and Psychiatry, 59, 55 – 60.

Starkstein, S.E., Sabe, L., Chemerinski, E., Jason, L., & Leiguarda, R. (1996). Two domains of anosognosia in Alzheimer's disease. Journal of Neurology, Neurosurgery, and Psychiatry, 61, 485 – 490.

Starkstein, S.E., Sabe, L., Cuerva, A.G., Kuzis, G., & Leiguarda, R. (1997). Anosognosia and procedural learning in Alzheimer's disease. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 10, 96 – 101.

Starkstein, S.E., Vasquez, S., Migliorelli, R., Teson, A., Sabe, L., & Leiguarda, R. (1995). A single-photon emission computed tomographic study of anosognosia in Alzheimer's disease. Archives of Neurology, 52, 415 – 420.

Terry, R.D. & Katzman, R. (1983). Senile dementia of the Alzheimer type. Annals of Neurology, 14, 497 - 506.

Terry, R.D., Masliah, E., Salmon, D.P., Butters, N., DeTeresa, R., Hill, R., Hansen, L.A., and Katzman, R. (1991). Physical basis of cognitive alterations in Alzheimer's disease: Synapse loss is the major correlate of cognitive impairment. Annals of Neurology, 30, 572 - 580.

Terry, R.D., Peck, A., DeTeresa, R., Schechter, R., & Horoupian, D.S. (1981). Some morphometric aspects of the brain in senile dementia of the Alzheimer type. Annals of Neurology, 10, 184 - 192.

Trosset, M.W. & Kaszniak, A.W. (1996). Measures of deficit unawareness for predicted performance experiments. Journal of the International Neuropsychological Society, 2, 315 – 322.

Tulving, E. (1994). Foreward. In J. Metcalfe & A.P. Shimamura (Eds.) Metacognition: Knowing about Knowing (pp. vii – x). Cambridge, MA: The Massachusetts Institute Of Technology Press.

Vasterling, J.J., Selzter, B., Foss, J.W., & Vanderbrook, V. (1995). Unawareness of deficit in Alzheimer's disease: Domain-specific differences and disease correlates. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 8, 26 – 32.

Verhey, F.R.J., Rozendaal, N., Ponds, W.H.M., & Jolles, J. (1993). Dementia, awareness, and depression. International Journal of Geriatric Psychiatry, 8, 851 – 856.

Wagner, M.T. & Cushman, L.A. (1994). Neuroanatomic and neuropsychological predictors of unawareness of cognitive deficit in the vascular population. Archives of Clinical Neuropsychology, 9, 57 – 69.

Wagner, M.T., Spangenberg, K.B., Bachman, D.L., & O'Connell, P. (1997). Unawareness of cognitive deficit in Alzheimer disease and related dementias. Alzheimer Disease and Associated Disorders, 11, 125 – 131.

Weinstein, E.A., Friedland, R.P. & Wagner, E.E. (1994). Denial/unawareness of impairment and symbolic behavior in Alzheimer's disease. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 7, 176 – 184.

Whitehouse, P.J., Lerner, A., and Hedera P. (1993). Dementia. In K.M. Heilman

& E. Valenstein (Eds.)., Clinical Neuropsychology (3rd Edition, pp. 603 - 645). New York: Oxford University Press.

Whitehouse, P.J., Price, D.L., Struble, R.G., Clark, A.W., Coyle, J.T., & DeLong, M.R. (1982). Alzheimer's disease and senile dementia: Loss of neurons in the basal forebrain. Science, 215, 1237 - 1239.

Yesavage, J.A., Brink, T.L., Rose, T.L., Lum, O., Huang, V., Adey, M., & Leirer, V.O. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. Journal of Psychiatric Research, 17, 37 – 49.