Remember To Turn Off the Stove!

Prospective Memory in Dementia

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Abstract

Dementia predominately affects older people, progressively affecting activities of daily living. Research shows prospective memory, the memory for future intentions, to be a sensitive indicator of dementia. Prospective memory is not routinely assessed in older people, yet testing prospective remembering could result in early diagnosis of dementia creating opportunity for early intervention. A retrospective analysis of the prospective memory subtest scores on the Rivermead Behavioural Memory Test (RBMT), a test of everyday memory, was completed for a group of older adults diagnosed with either vascular dementia (n=35) or Alzheimer's disease (n=39) aged 60-89 years. These individuals participated in a study by Glass (1998) exploring the possibility of discrimination between vascular dementia and non-vascular dementia using the RBMT. Glass's findings indicated that a combination of four subtests, two of which assessed prospective memory, were able to classify a case as vascular or non-vascular with an error rate of 2.7% out of the 74 cases analysed. The question that rose from that data was, what would be the predictive validity of the 3 prospective memory subtests if the individual scoring components were analysed separately? Glass's data was reviewed and analysed using nonparametric and Chi Square statistical analysis. Analysis indicated that the components that assessed the prospective element of prospective memory were more predictive of vascular dementia (VAD) and dementia of the Alzheimer's type (DAT) than the retrospective element. Individual subtest scoring components indicated significant differences between VaD and DAT on 'delayed message', 'delayed location' and 'spontaneous appointment request'. Unexpectedly, there was also a significant gender difference within the DAT group favouring males on the scoring component

'delayed message'. It was also significant that the PM performance of VaD females exceeded that of the DAT females on the subtests 'delayed message' and 'appointment'. Differences in prospective memory performance between VaD and DAT were not substantial enough to support the use of PM performance as a discriminator between VaD and DAT in a clinical setting but may be useful as an additional marker in differential diagnosis.

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Chapter One

Overview

The idea for this present study came from Dr John Glass a clinical psychologist of older persons based at the Taranaki Base Hospital in New Plymouth. In 1999 he reported the results from his doctoral study on the relevance of everyday memory and the Rivermead Behavioural Memory Test (RBMT). As part of this study Glass (1998) compared the RBMT subtest scores in cases diagnosed as vascular (VaD) or probable dementia of the Alzheimer's type (DAT).   Analysis found that 6 of the 12 RBMT subtests yielded consistently low error rates and were therefore discriminated between VaD and DAT. Two of the six were the Prospective Memory subtests – Appointment and Message. A third prospective memory subtest, Belonging was not found to have discriminative validity. Further analysis led to the finding that just 4 subtests in combination, could classify a case as VAD or DAT with an error rate of 2.7% out of the 74 cases analysed. The subtests eliminated from the 4-subtest analyses were the two delayed recall subtests (Route and Story). Both of these relied on retrospective memory. Each of the three prospective memory subtests incorporates a 'delayed' recall component with a 'prompt' provided to remind the examinee that something needs to be done. The question raised by this data, but not examined by Glass, is what would be the predictive validity of the 3 prospective subtests if the individual scoring components were analysed separately? This study seeks to answer that question.

If the prospective memory subtests do have predictive validity in discriminating between cases of VaD and DAT as indicated by Glass (1998), prospective memory impairment may become an important biomarker for earlier more accurate diagnosis of dementia. With New Zealand's aging population due to increase dramatically over the next decade the prevalence of dementia will also increase. Earlier diagnosis of dementia type could provide opportunities for earlier treatment, as current treatments appear to be of greater benefit during the milder stages of the disease early identification is important.

This thesis commences with a discussion on older people in New Zealand through a literature review of the cognitive changes in normal aging, mild cognitive impairment (MCI) and dementia. Mild cognitive impairment as a clinical diagnosis has emerged since the Glass (1998) study and therefore was not examined at that time. As the participants for this study are predominately those from the Glass (1998) study, MCI could not be investigated in this study either. Nevertheless MCI is very relevant to the changing face of dementia therefore a review of the current literature is included. Dementia encompasses a range of disorders, this study focuses on two: VaD and DAT. Chapter 2 concludes with a brief summary before the focus turns to the topic of memory.

Chapter 3 outlines the types of memory that are relevant to this study before a more in depth discussion on prospective memory; its relationship to mild cognitive impairment and dementia, as well as the difficulties involved in its measurement. The RBMT is introduced and a breakdown of the three prospective memory subtests is given. To complete the literature review a summary of the chapter is provided before a reinstatement of the aims of this study.

The method section forms chapter 4 and begins with a statement of the hypotheses before giving an outline of the procedure used and the participants involved in the study. Thereafter the results are laid out in chapter 5 followed by a discussion of the findings in Chapter 6. The limitations of the study are subsequently outlined before a concluding statement completes the study.

Chapter Two

Age-related Cognitive Impairment and Dementia

2.1   Older people in New Zealand

The New Zealand population is aging at a faster rate than ever before. Statistics New Zealand makes the following projections: By 2036 it is expected that there could be up to 1.25 million people aged over 65 years, double from that in 2012. By 2061 the figure is expected to escalate as far as 1.66 million with up to 30% of the population aged 65 or over. Lower birth rates combined with longer life expectancy has resulted in the median age of New Zealanders increasing from 26 years in 1971 to 37 years in 2012. By 2061 median life expectancy for males will be 88.1 years and 90.5 years for females. It is predicted that by 2061 half of the New Zealand population will be older than 44 years (Statistics NZ, 2011). This is likely to mean a significant proportion of the population will be living with dementia as being over the age of 65 years is the greatest risk factor for developing dementia.

2.2   Normal Aging

Aging is a normal human process and just as the body ages so does the mind. Cognitive decline is part of the normal aging process rather than an early pathologic process. Normal aging negatively affects memory with increased forgetfulness and difficulties in retaining new information. Normal aging affects memory to different degrees with

remote memory tending to remain stable (Polino, Desgranges, Benali & Eustache, 2002), and recent memory much more likely to be impaired (Ofen & Shing, 2013). Recent memory encompasses both primary and secondary memory. Primary memory involves the encoding of new information and encoding speed slows with increasing age (Strayer, Wickens, & Braune, 1987). Primary memory is of limited capacity and storage of information to be retained for longer periods must be transferred into secondary (long term) memory. It is the transferring of this information that is the more severely affected by normal aging as the processing resources supporting encoding become less efficient (Cansino, Trejo-Morales, & Hernandez-Ramos, 2010).

Changes occur to structural and functional areas of the brain specifically the pre-frontal cortex and the temporal medial lobe regions and both of these areas are specifically associated with episodic encoding (Kirchhoff, Wagner, Maril, & Stern, 2000; Persson et al., 2006). Another area affected by aging is the volume of grey matter which reduces with age as a result of reduced density of the synapses (Resnick, Pham, Kraut, Zonderman, & Davatzikos, 2003; Terry, 2000). Aging also results in a reduction of dopamine receptors affecting the frontal and cingulate brain regions as the dopamine system deteriorates (Kim et al., 2011; Volkow et al., 2000). Dopamine receptors have been implicated in the regulation of attention, perceptual speed, episodic and working memory function (Backman et al., 2000; Volkow et al., 2000).

Long term memory of acquired knowledge and skills is not as susceptible to the effects of aging so generally does not decline significantly. Knowledge and skills are crystallised abilities that develop over the lifespan through education, occupational, social and

cultural experiences (Anstey & Low, 2004). However fluid abilities such as processing speed and problem solving are particularly susceptible to the effects of normal aging (Anstey & Low, 2004). Both of these depend on the use of short term memory (a component process of working memory) for storage while processing information. Attention and information processing speed also decline with age with slowed processing speed partially responsible for age related effects in other cognitive areas (Salthouse, 2000). It was initially thought that information processing speed was subject to general decline with aging but Bashore, Ridderinkhof & van der Molen (1997) found that with aging a variety of influences affect processing speed and rather than a generalised slowing of processing speed as initially thought the effects of aging on processing speed can be quite selective.

Hedden and Gabrieli (2004) highlighted the difficulty of separating normal age related changes from those that are pathological, particularly given the long preclinical period of some types of dementia. This difficulty is one of the reasons the long preclinical period of Alzheimer's disease (DAT) has resulted in the conceptualisation of mild cognitive impairment which can now be differentiated from normal aging and DAT. An added difficulty though, is the challenge of differentiating pathological memory changes from changes in memory as a result of depression which can often have a similar presentation (Anstey & Low, 2004). Table 1 outlines the differences in memory presentation between normal aging, dementia and depression.

Table 1

Memory Complaints in Normal Aging, Depression and Dementia

Normal Aging	*Depression*	*Dementia*
Minimal complaints about memory	Often complain of memory difficulties	No awareness of memory difficulties or variable generalised complaints about memory
Rate of forgetting relatively normal	Rate of forgetting relatively normal	Rapid rate of forgetting
Unclear onset. Cognition on testing is normal.	Sudden onset. Mild cognitive impairments on testing that resolve on recovery	Gradual onset. Impaired cognition on testing that progressively declines over time.
No interference with daily activities.	Can interfere with daily activities.	Interferes with daily activities.
No change in mood.	Mood depressed or anxious	Mood may be liable or blunted
No difficulty carrying out tasks.	Little effort shown on tasks.	Struggles to carry out tasks.

(Adapted from Anstey & Low, 2004; Snyder, Nussbaum, & Robins, 2006)

2.3 Mild cognitive impairment

Mild cognitive impairment (MCI) is a clinical diagnosis that has often been seen as the precursor to DAT or as a transitional stage between memory loss due to normal aging and DAT. Older adults who develop MCI are more at risk of going on to develop DAT (Petersen et al., 2001). Episodic memory becomes impaired with deficits in encoding, storage and retrieval of information noted years before a clinical DAT diagnosis is given (Jones, Livner, & Backman, 2006). Alzheimer's disease tends to have a long preclinical phase and if MCI is predictive of DAT, opportunities open up for intervention before impairment reaches the level of clinical DAT.

2.3.1   Prevalence of mild cognitive impairment

Mild cognitive impairment is a relatively new concept and with no consensus until recently on diagnostic criteria. Reported prevalence rates for MCI have been highly influenced by the criteria applied. A study by Visser & Verhey (2008) put the incidence rate of MCI at 13–15% for people aged between 70 and 89. Petersen et al. (2009) examined MCI studies published from 2001 to 2008 and concluded that prevalence rates for people 70 years and older ranges between 14-18%. Prevalence of MCI increases in older age groups (Visser & Verhey, 2008) and there is a higher prevalence of men with MCI. Petersen et al., (2010) relate this to more women transitioning straight from normal aging to dementia. Other studies have noted MCI incidence rates ranging from 5.3% (Hanninen, Hallikainen, Tuomainen, Vanhanen, & Soininen, 2002) to 22% (Lopez et al., 2003). One study that compared prevalence rates using four different MCI diagnostic criteria found incident rates varied from 3-20% depending on the criteria used (Busse, Bischkopf, Riedel-Heller, & Angermeyer, 2003). Risk factors associated with developing MCI are increasing age, lower education and hypertension (Luck, Luppa, Briel, & Riedel-Heller, 2010).

2.3.2   Diagnostic Criteria

The use of different MCI diagnostic criteria in research studies has made it difficult to establish accurate prevalence rates. Some studies used particularly stringent criteria that stipulated that impairment in memory be present without impairment in other cognitive areas. These criteria were deemed to be too stringent for use with a general population sample (Ritchie, Artero, & Touchon, 2001) as there is growing evidence that MCI can involve deficits in other areas of cognitive functioning. These issues highlighted the need

for a consensus on the definition of MCI. This was addressed at the First Key Symposium held in Stockholm in 2003, by the International Working Group on MCI made up of multidisciplinary experts from around the world. The working group recommended that the general criteria for MCI be: Not normal, not demented; cognitive decline evidenced either by self-report or informant report and/or there has been decline over time on objective cognitive tasks; activities of daily living are preserved and there is minimal impairment in complex functional activities. Three subtypes of MCI were proposed for use in clinical classification: amnestic (memory domain only affected), multiple domain (mild deficits in a number of cognitive domains) and single non-memory domain (e.g. language) (Winbald, Palmer, Kivipelto, Jelic, Fratiglioni, et al., 2004).

By 2011 separate criteria were established for clinical use and research use. Included in the research criteria was the use of imaging and cerebrospinal fluid biomarkers with the diagnostic classification terms: MCI due to DAT – intermediate likelihood; MCI due to DAT – high likelihood and MCI due to DAT – unlikely due to DAT (Albert et al., 2011). In May 2013 the latest version of the Diagnostic and Statistical Assessment Manual of Mental Disorders (DSM-5) was released (American Psychiatric Association, 2013). MCI is now recognised and included as Mild Neurocognitive Disorder characterised by a decline in cognitive functioning. This decline requires the use of strategies and accommodations for the continuation of daily activities to maintain independence.

In New Zealand, MCI is commonly being used as a diagnostic term within clinical practice with over 80% of surveyed clinicians using the term to inform patients and their families

and over 70% of clinicians rating the importance of separating MCI from dementia as important or very important (Mitchell, Woodward, & Hirose, 2008).

2.3.3   Progression of mild cognitive impairment

Adding to the difficulty in establishing prevalence rates has been the lack of stability in MCI. While a diagnosis of MCI increases the risk of developing dementia (Bennett et al., 2002), it appears that not all people diagnosed with MCI will progress on to develop dementia. A surprising finding from a longitudinal study was the incidence of more than 40% of people identified with MCI that 2-3 years later had returned to normal cognitive levels (Larrieu et al., 2002). The same effect had been noted in a previous study where people classified with MCI one year did not meet the diagnosis a year later (Ritchie et al., 2001) and in a later study 26-32% of those diagnosed with MCI had reverted back to normal cognition 5 years later (Fisk, Merry, & Rockwood, 2003). This may be reflective of methodological challenges in assessing cognitive performance (Schinka et al., 2010) or may be reflective of the remittance of cognitive difficulties following recovery from a depressive episode (Anstey & Low, 2004). The latter view has merit as 20% of people with MCI experience depression (Lyketsos et al., 2002).

Progression from MCI to dementia ranges from about 10-15% per year in referral clinic settings to 6-10% per year in epidemiologic studies (Busse et al., 2003; Petersen, 2004; Petersen et al., 2009). In a clinical setting, conversion rates as high as 25% at one year have also been reported (Devine, Fonseca, & Walker, 2013). A number of studies have examined the predictive accuracy of MCI for dementia with some studies reflecting MCI to be a poor predictor of dementia (Larrieu et al., 2002; Ritchie et al., 2001). It is likely

though that reported progression rates have also been influenced by the use of different diagnostic criteria. A number of factors have now been identified as influencing the rates of progression from MCI to dementia. These include the clinical severity of symptoms; evidence of atrophy on MRI; being a carrier of the Apolipoprotein E4 gene; the presence of hypometabolism in the temporoparietal regions; the presence of known biomarkers for Alzheimer's disease and a positive amyloid imaging scan (Brainerd et al., 2013; Petersen et al., 2009). Age influences predictive accuracy with predictive accuracy greatest for those in the 70-80 year bracket (Visser & Verhey, 2008).

Initially any progression from MCI to dementia was thought to be to DAT. However a 2002 study not only identified 47.9% of patients progressing from MCI to DAT but found that 20.5% of MCI patients developed VaD (Meyer, Xu, Thornby, Chowdhury, & Quach, 2002). Cognitive deficits similar but not as severe as those in DAT were noted three years before a clinical diagnosis of VaD (Laukka, Jones, Small, Fratiglioni, & Backman, 2004). A common factor in the VaD cases was the presence of small-vessel dementia whereas 44.4% of the remaining VaD cases had multi-infarct or strategic-infarct dementia with no evidence of MCI prior to the presence of VaD (Meyer et al., 2002). Laukka et al., (2004) expand on this by suggesting that circulatory disturbances negatively affect cognitive functioning in the preclinical phase of VaD. A 2009 meta-analysis suggests annual conversion from MCI to DAT and other non vascular dementias is around 7% and conversion to VaD is about 2% but most people did not convert from MCI to dementia (Mitchell & Shiri-Feshki, 2009). The presence of vascular risk factors such as diabetes, hypertension, high cholesterol and cerebrovascular diseases increase the likelihood of conversion from MCI to DAT (Li, et al., 2011).

MRI has identified a prodromal phase of MCI that leads to VaD characterised by widespread white matter lacunar infarcts that are less severe than those seen in VaD with minimal hippocampal atrophy (Meyer, Huang, & Chowdhury, 2007). Also noted is smaller cerebellar volume in people with MCI that progress to VaD than those who progress to DAT (Yoon, Seo, et al., 2013).

Early identification of MCI provides opportunities for early intervention, particularly with the drug therapies that are currently targeted at DAT, to slow or arrest the progression to dementia (Larrieu et al., 2002). Identifying older people at greater risk of developing dementia early may allow for more timely strategic health care planning both at a primary level between doctors and patients and at a tertiary level in public health planning as countries endeavour to manage an increasingly larger aging population (Winbald, Palmer, Kivipelto, Jelic, & Fratiglioni, 2004).

Petersen et al. (2004) agree that early identification is important but note that effective treatment has yet to be discovered. Results of trials applying current therapies for DAT to MCI have been disappointing. A review of five trials of Acetylcholinesterase inhibitors found there was no effect on MCI (Petersen et al., 2009). There have though been some promising results emerging. B-Vitamins taken over a 2 year period slowed cognitive decline and brain atrophy in people diagnosed with MCI, particularly in those who had pre-existing high plasma total homocysteine concentrations (de Jager, Oulhaj, Jacoby, Refsum, & Smith, 2012; Smith et al., 2010). Lithium treatment was not found to be effective on DAT but a double blind study found lithium taken for a year by participants

with MCI was effective at reducing cognitive decline, possibly due to the less advanced cognitive decline in MCI (Forlenza et al., 2011). In New Zealand, only 25% of surveyed clinicians recommended pharmacological treatment for MCI while other clinicians recommended either no treatment or the use of complimentary therapies with most recommending a follow-up appointment at 6-12 months (Mitchell et al., 2008).

2.4   Dementia

Dementia refers to a group of disorders characterised by cognitive complaints that include memory and other impairments that exceed what would be expected from normal aging. There are at least 14 disorders under the dementia umbrella as listed in Table 2, including Alzheimer's disease, Vascular disease, Parkinson's disease and Lewy body dementia (Snyder et al., 2006). Common symptoms of dementia include difficulties with memory, executive functioning, visuospatial ability and language as a result of brain deterioration. The onset and progression of dementia is dictated to a large extent by its etiology. For a diagnosis of any of the dementias cognitive impairment must significantly impact on social and occupational functioning with a notable decline from previous levels of functioning (American Psychiatric Association, 2000). Commonly used diagnostic criteria include the National Institute of Neurologic, Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) research criteria, recently revised to recognise advances in knowledge of the biology and clinical expressions of DAT (Dubois et al., 2007). Among the changes was the integration of biomarker evidence to support clinical diagnosis of dementia in research settings (McKhann et al., 2011). Also in frequent use is the Diagnostic and Statistical Manual of

Mental Health Disorders (DSM-IV) which has, in the last few months, been superseded by the DSM-5 that also recognises advances in the field of dementia research. The two most common forms of dementia are Alzheimer's disease and Vascular dementia respectively with Alzheimer's disease making up between 65-90% of all dementia diagnoses (Barker et al., 2002). These are the dementia types diagnosed in the sample examined in this study, being reported in this thesis.

Table 2

Etiologies of Dementia

Alzheimer's disease	Parkinson's disease
Vascular dementia	Huntington's disease
Lewy body dementia	Hydrocephalus
Creutzfeld-Jacob disease	HIV disease
Frontotemporal dementia	Substance induced dementia
Pick's disease	Head trauma
Multiple sclerosis and demyelinating disorders	

(From Snyder et al., 2006)

2.4.1   Prevalence of dementia

The New Zealand Ministry of Health estimates the prevalence of dementia to be around 8% of those aged 65 years and over (Lewis, 2002). To date there have been no epidemiological studies of the prevalence or incidence of dementia in New Zealand. As a result New Zealand prevalence rates have been estimated based on international prevalence reports. In 2014 there will be an estimated 52,509 people with dementia in New Zealand, an increase from 48,182 people in 2011 (Deliotte Access Economics, 2011). As a result of New Zealand dementia prevalence rates being estimated there is no data on

the prevalence of dementia in Maori and Pacific Island people living in New Zealand. The proportion of older Maori relative to older non-Maori is expected to double over the next 13 years and currently Maori experience poorer health than other New Zealanders (Ministry of Health, 2011). Therefore Maori as well as Pacific people are likely to be at greater risk of developing dementia. Maori tend to be underrepresented in dementia services but the use of a bicultural model of dementia care in Northland is showing promising results in increasing Maori engagement in dementia care services (Martin & Paki, 2012). Prevalence of dementia is expected to increase significantly over the coming decades with an estimated 88,309 people with dementia in 2030 and 147,359 people in 2050. These figures represent a more than two fold increase over 35 years from 1.2% of the total New Zealand population in 2014 to 2.6% of the population by 2050 (Deloitte Access Economics, 2011). Prevalence rates for dementia are higher for females than males, particularly for DAT with prevalence rates 1.5-2.7 times higher in females. Overall incident rates do not differ significantly for gender although incidence rates of VaD are higher for males and rates of DAT are higher for females after age 90 than for males (Takeda, Tanaka, & Kudo, 2011). As females live longer there will continue to be a greater proportion of older women than older men living with dementia. These projections are a cause for concern, particularly if little has changed since 2005 when many New Zealand District Health Boards identified that there was poor provision for dementia care (Melding, 2005). Under-recording of dementia attributed deaths is also cause for concern as dementia may not receive the level of future planning attention that will be required to meet the needs of the growing population of people with dementia in New Zealand. Tobias, Yeh & Johnson (2008) note in 2006 there were 690 deaths attributed to DAT whereas they estimated the figure to be closer to 2300 DAT attributed deaths.

2.4.2   Alzheimer's Disease

Alzheimer's disease is distinguished by an insidious onset with progressive cognitive decline that interferes with the ability to work or perform usual activities (McKhann et al., 2011). In 86-94% of cases DAT follows a typical amnesic pattern with episodic memory complaints the primary feature followed by the progressive involvement of semantic memory, attentional processes, visuospatial abilities and language (Carter, Caine, Burns, Herholz, & Lambon Ralph, 2011; Galton, Patterson, Xuereb, & Hodges, 2000) as shown in Table 3.

Table 3

DSM-IV-TR Criteria for the Diagnosis of Dementia of the Alzheimer's Type

A. The development of multiple cognitive deficits manifested by both:
   1. Memory impairment (impaired ability to learn new information or to recall previously learned information).
   2. One or more of the following cognitive disturbances:
      (a) Aphasia (language disturbance).
      (b) Apraxia (impaired ability to carry out motor activities despite intact motor function).
      (c) Agnosia (failure to recognise or identify objects despite intact sensory function).
      (d) Disturbance in executive functioning (i.e., planning, organising, sequencing, abstracting).
B. The cognitive deficits in criteria A1 and A2 each cause significant impairment in social or occupational functioning and represent a significant decline from a previous level of functioning.
C. The course is characterised by gradual onset and continuing cognitive decline.
D. The cognitive deficits in criteria A1 and A2 are not due to any of the following:
   1. Other central nervous system conditions that cause progressive deficits in memory and cognition (e.g. cerebrovascular disease, Parkinson's disease, Huntington's disease, subdural hematoma, normal-pressure hydrocephalus, brain tumor).
   2. Systemic conditions that are known to cause dementia (e.g. hypothyroidism, vitamin B12 or folic acid deficiency, niacin deficiency, hypercalcemia, neurosyphilis, HIV infection).
   3. Substance-induced conditions.
E. The deficits do not occur exclusively during the course of a delirium.
F. The disturbance is not better accounted for by another Axis I disorder (i.e. Major Depressive Disorder, Schizophrenia).

(From American Psychiatric Association, 2000)

A seven stage framework describing the progressive path of DAT was developed in 1984 (Reisberg et al., 1984) and now forms the basis of the Functioning Staging of Dementia of the Alzheimer's Type (FAST) diagnostic tool in common use in the United States of

America. An overview of the seven stages follows. Stage one: No impairment; Stage two: very mild cognitive decline, a little forgetful but no symptoms of memory loss that are evident on screening. Stage three: mild cognitive impairment, some difficulties are noticed by others and will often include forgetting new information, misplacing items of value and having difficulty with planning. Stage four: Moderate cognitive decline related to early stage dementia. Difficulties increase with problems in recalling recent events and personal history, difficulties with complex tasks such as paying accounts or solving problems and behaviour changes may also occur. Stage five: Moderately severe cognitive decline, greater memory deficits such as forgetting your home address. Help is needed with day to day activities but not with personal cares. Stage six: Severe cognitive decline describes mid stage DAT: with help needed with personal cares; lack of awareness of recent events; a tendency to wander and become lost; personality and behaviour changes. Stage seven: loss of the ability to interact with the environment and no longer able to maintain a conversation. Movement is affected resulting in abnormal reflexes, muscle rigidity and loss of the ability to smile or sit unaided. Death may follow a coma. (Adapted from Sclan & Reisberg, 1992).

The cause of DAT is not yet known although most experts agree that there are multiple factors involved in its development rather than just one cause. Genetic factors are thought to be involved in the development of the disorder for some people. The Apolipoprotein E4 gene has been implicated as a factor in the origin of over half of all cases of DAT. A study by Corder et al., (1993) found that the proportion of people affected with DAT increased as the number of E4 genes present increased. This ranged from 20% of affected participants who had one E4 gene; 47% of affected participants with

two or three E4 genes to 91% of participants with four E4 genes. Therefore participants

with four E4 genes were 8 times more likely to be affected by DAT than participants with

two or three E4 genes. Diagnostic testing for this gene has not been useful though as

nearly half of all people with DAT do not carry this gene and it can be found in people

without dementia. The presence of the gene though increases the susceptibility of

developing the disease (Lindsay et al., 2002). Recent research indicates that the E4 gene

is a risk factor for transitioning from normal functioning to MCI but not from MCI to

dementia indicating that those with MCI are the main source of those with DAT (Brainerd

et al., 2013).

Also implicated in the development of DAT has been the neurotransmitters acetylcholine

and norepinephrine. Dopamine is required by the hippocampus for the consolidation of

memories and as people age dopamine levels reduce, adding to the memory difficulties of

older people. Recent research suggests that increasing the levels of dopamine in older

people by administering an optimal dose of dopamine enhances the consolidation of

memories after encoding (Chowdhury, Guitat-Masip, Bunzeck, Dolan, & Duzel, 2012).

2.4.3   Brain pathology of Alzheimer's disease

Alzheimer's disease is characterised by excessive amyloid deposition creating plaques, the

presence of neurofibrillary tangles and chonlinergic dysfunction. Plaques and tangles are

often found in the areas of the brain involved with memory along with damaged synapses

and neurons (Mattson, 2011). Synapse loss is strongly correlated with cognitive

impairment in mild DAT (Scheff, Price, Schmitt, DeKosky, & Mufson, 2007; Terry et al.,

1991). Carter et al., (2011) highlight the regions affected by DAT, namely: hippocampus,

parahippocampal gyrus, temporoparietal cortex, posterior cingulated cortex, anterior

temporal lobe, medial prefrontal cortex and the medial temporal lobe. Frontal and

temporal cortical lobes show significant atrophy in DAT and MCI when compared with

normal aging. Also while hippocampal atrophy and ventricular enlargement has been

noted in normal aging, impairment is significantly greater in DAT and in MCI but to a

lesser extent than in DAT (Apostolova et al., 2012; Convit et al., 1997; Meyer et al., 2007).

Atrophy of the hippocampus results in deficits in anterograde episodic memory as

demonstrated in DAT by a difficulty in encoding new information into long term memory

thereby affecting recognition and recall of information (Graham, Emery, & Hodges, 2004).

Hippocampus atrophy is also correlated with lower levels of performance in tests of

executive function (Oosterman, Oosterveld, Olde Rikkert, Classsen, & Kessels, 2012).

2.4.4   Treatment and prevention

Possible influences on the course of DAT have attracted research on a broad range of

factors with a number of promising results. A higher level of education is a protective

factor by providing a cognitive reserve (Dufouil, Alperovitch, & Tzourio, 2003). Folate

taken at or above daily recommended levels was found to reduce the risk of developing

DAT (Corrada, Kawas, Hallfrisch, Muller, & Brookmeyer, 2005) as is involvement with

regular physical exercise (Larson et al., 2006; Lindsay et al., 2002; Rovio et al., 2005) and

leisure activities (Crowe, Andel, Pedersen, Johansson, & Gatz, 2003; Scarmeas, Levy, Tang,

Manly, & Stern, 2001). Reduced engagement in intellectual activities in midlife was found

to be a risk factor for the development of dementia up to four decades later although the

suggestion was raised that reduced participation may be due to progressive effects of the

disease (Friedland et al., 2001). Use of nonsteroidal anti-inflammatory drugs was

identified as a protective factor against risk of DAT (Anderson et al., 1995; Lindsay et al., 2002; Stewart, Kawas, Corrada, & Metter, 1997; Veld et al., 2001) as is the management of vascular risk factors related to carotid artery and cardiovascular pathology that increase the risk of developing DAT, see de la Torre, (2010) for review.

As much as possible efforts should be directed towards prevention of DAT as once the disease develops there is currently no cure. With the preclinical phase of DAT lasting up to 10 years there are opportunities for early detection and an intervention may delay the onset of the disease (Laukka, MacDonald, Fratiglioni, & Backman, 2012). The standard drug therapy treatment of DAT is with cholinesterase inhibitors (Cummings, 2003). Cholinesterase inhibitors were found to be initially beneficial both cognitively and functionally but the benefits reduce as the disease progresses. The initial benefits were such that they delayed the decline of the disease resulting in later entry into rest homes, a significantly positive effect of the treatment (Lopez et al., 2002). Cholinesterase inhibitors are most effective during the mild to moderate stages of DAT and it is recommended that treatment with cholinesterase inhibitors begin as soon as possible following a diagnosis of DAT for the best outcome; withdrawal and re-initiation of the drug is not recommended due to loss of benefit (Cummings, 2003). In the U.S. five drugs were approved for DAT treatment and on average slowed the progression of symptoms for 6-12 months in about half of those who used them (Mebane-Sims, 2009). Medication is used to manage the behavioural and psychological symptoms of dementia and the choice of medication is made based on clinical experience. Behavioural and psychological symptoms can include anxiety, depression, hallucinations, verbal and physical aggression, delusions, insomnia and sexual inhibition. In New Zealand and Australia atypical

neuroleptics is the treatment of choice for most of the behavioural and psychological symptoms of dementia (Greve & O'Connor, 2005). Novel antidepressants are the medication of choice for anxiety symptoms, benzodiazepine for insomnia, with mood stabilisers and cholinesterase inhibitors also seen to be useful in the treatment of dementia symptoms (Greve & O'Connor, 2005). Cholinesterase inhibitors are particularly applicable for patients with health complications, where using antipsychotic medications would be associated with significant risk (Cheung & Stapelberg, 2011).

2.4.5   Vascular dementia (VaD)

VaD has a broad etiology resulting in brain lesions from cerebrovascular disease or cardiovascular pathology. VaD has a heterogeneous nature that includes a number of subtypes of cerebrovascular disease. VaD can be categorised by onset into two groups. The first group, cortical dementia, shows a sudden onset as a result of strategic-infarct, multi-infarct or intracranial haemorrhage affecting large blood vessels. In the other, subcortical dementia, which is the most common type, onset is slow and causation is generally due to disease of the subcortical small blood vessels (Meyer et al., 2002; Roman, 2003). There is often however, a degree of overlap between the two. Sub cortical cognitive loss is predominant in both groups (Roman, 2003). A New Zealand study into the long term outcomes of experiencing a stroke found that shortly after experiencing a stroke 20% of people developed dementia and a recurrent stroke increased the occurrence of dementia to a third. Being Maori, Pacific or female was related to poorer outcomes (Feigin et al., 2010).

VaD is associated with deficits in attention and executive function. Executive function encompasses the abilities of problem solving, planning, goal execution and complex behaviours. Executive dysfunction was examined as a possible diagnostic marker for VaD but executive dysfunction was found to be predominant in only 45% of VaD cases compared to memory loss being predominant in 71% of cases of DAT. So whereas memory loss greater than the degree of executive dysfunction points towards DAT the opposite is not the case for VaD (Reed et al., 2007). In one study executive dysfunction was noted in healthy older women three years before memory deficits were identified (Carlson, Xue, Zhou, & Fried, 2009). Other areas of cognitive impairment in VaD include language, praxis, orientation, constructional abilities and memory (American Psychiatric Association, 2000). The diagnostic criteria for VaD are described in Table 4.

Table 4

DSM-IV-TR Criteria for Vascular Dementia

A. The development of multiple cognitive deficits manifested by both
1. Memory impairment (impaired ability to learn new information or to recall previously learned information).
2. One (or more) of the following cognitive disturbances:
    (a) Aphrasia (language disorder).
    (b) Apraxia (impaired ability to carry out motor activities despite intact motor function).
    (c) Agnosia (failure to recognise or identify objects despite sensory function).
    (d) Disturbance in executive functioning (i.e. planning, organising, sequencing, abstracting).
B. The cognitive deficits in criteria A1 and A2 each cause significant impairment in social or occupational functioning and represent a significant decline from a previous level of functioning.
C. Focal neurological signs and symptoms (e.g. exaggeration of deep tendon reflexes, extensor plantar response, pseudobulbar palsy, gait abnormalities, weakness of an extremity) or laboratory evidence of cerebrovascular disease (e.g. multiple infarctions involving cortex and underlying white matter) that are judged to be etiologically related to the disturbance.
D. The deficits do not occur exclusively during a course of a delirium.

(From American Psychiatric Association, 2000)

2.4.6 Brain pathology of vascular dementia

Which parts of the brain are impacted by VaD depends on where infarcts or lesions are situated (Desmond et al., 1999). As the name suggests multi-infarct dementia is likely to affect a number of brain sites. As previously noted deficits in executive functioning are common. Executive functioning is governed by a combination of the prefrontal cortex, thalamus, and the striatum-pallidum (Royall et al., 2002). The prefrontal cortex includes the orbitofrontal, dorsofrontal and cingulate cortex; damage to which results in executive

dysfunction as do lesions to the thalamus, striatum or pallidum (Royall et al., 2002). The extent of cognitive dysfunction in VaD has been correlated with the vastness of white matter pathology and lesions located in the thalamus and basal ganglia rather than the quantity or size of infarctions (Sachdev et al., 2004). In vascular dementia there is less hippocampal atrophy than in DAT along with a corresponding reduction in impairment on recall tests (Graham, 2004).

A particular subtype of VaD caused by subcortical microvascular disease presents with a progressive onset that is preceded by MCI in a similar pattern to DAT with similar cognitive domains affected (Meyer et al., 2002). These similar pathologies can make differential diagnosis between DAT and VaD difficult as can the presentation of Dementia of mixed etiology which has features of both DAT and VaD. Vascular dementia itself can be difficult to diagnose and only a small portion of those diagnosed with VaD actually simultaneously meet the criteria of the five different classification systems (Wetterling, Kanitz, & Borgis, 1996). One of the most common diagnostic criteria for VaD is the presence of white mater lesions on the brain. This criterion has been criticised as white mater lesions have been found to be present in normal aging (Nagata et al., 2007) and lesions are also present in up to 30% of those with DAT (Roman, 2003).

Management of risk factors for stroke and vessel disease can prevent the development of VaD. Prevention of recurring stroke is managed through the use of blood thinning agents to lower blood pressure. A review of studies by O'Brien et.al (2003) suggests that cholinesterase inhibitors may be useful in the treatment of VaD as is the use of calcium antagonist and vasodilator nimodipine in subcortical vascular dementia. Long term use of

non-steroidal anti-inflammatory drugs has not been effective protection against VaD

(Veld et al., 2001). Engaging in regular physical activity in midlife appears to be a

protective factor as higher levels of fitness in midlife reduce the risk of developing

dementia in later life (DeFina et al., 2013).

2.4.7 Similarities and differences between VaD and DAT

In the early stages of dementia, neuropsychological profiles can be useful in the

characterisation of dementia but as dementia progresses there is a blurring of the

symptom domain boundaries making it difficult to discriminate between dementias

(Roman, 2003). The features of VaD and DAT are shown in Table 5. There are differences

though in the preclinical trajectories of VaD and DAT. DAT tends to have a longer

prodromal period than VaD but once people with VaD start to decline the acceleration of

deterioration is faster (Laukka et al., 2012). Symptoms can often be similar; both DAT and

VaD can have similar vascular risk factors making it difficult to identify the primary cause

of impairment (de la Torre, 2010). There tends to be some notable differences though.

As noted above, executive dysfunction is common in VaD but memory impairment can

often be mild or non-existent with verbal long term memory likely to be preserved (Looi

& Sachdev, 1999; Roman, 2003). Although deficits in semantic memory, attention and

visuospatial skills are likely to be greater in VaD than in DAT (Graham et al., 2004).

Executive dysfunction is also greater in VaD than in DAT (Yoon, Shin, et al., 2013).

Whereas information decay or rapid forgetting is characteristic of DAT (Vanderploeg,

Yuspeh, & Schinka, 2001) as are false positive errors (Yuspeh, Vanderploeg, Crowell, &

Mullan, 2002). Furthermore cues are unlikely to be beneficial in the retrieval of

information in DAT (Desmond, 2004) whereas in VaD forgetting is less significant and

people with VaD are more likely to benefit from a cue (Erkinjuntti et al., 2000). There

may be difficulties in acquiring new knowledge but once acquired it is retained (Sachdev

et al., 2004).

Retention of new information in DAT is usually difficult with episodic memory generally

impaired in those with DAT particularly on tests of delayed recall (Graham et al., 2004;

Heyanka, Mackelprang, Golden, & Marke, 2010). Memory loss usually exceeds any deficit

in executive functioning in those with DAT (Graham et al., 2004; Reed et al., 2007).

Frontal lesions in VaD do not impair recall of cued information (Royall et al., 2002). This is

confirmed by tests of delayed recall that have been found to discriminate between DAT

and VaD with 81% accuracy. Higher scores on a test of delayed recall were found to

indicate VaD and low scores indicated DAT (Graham et al., 2004). Mathias & Burke (2009)

dispute that cognitive tests can differentiate between VaD and DAT following a meta-

analytic review of neuropsychological tests used with VaD and DAT. However the meta-

analysis did not include tests of prospective memory which have shown some promising

results and will be discussed later.

X-ray CT and MRI are structural brain imaging techniques that have been used to

diagnosis dementia. With technological advances MRI provides a sensitive device for

discriminating between dementias (Wolf-Dieter & Zimmermann-Meinzingen, 2012).

Structural imaging has identified global volume loss and medial temporal atrophy in both

dementias although atrophy of the medial temporal lobes is generally milder in VaD.

Parietal atrophy shows in DAT while cortical infarctions can be seen in VaD (Mortimer,

Likeman, & Lewis, 2013). Functional imaging of DAT tends to show temporoparietal

hypoperfusion or hypometabolism while in VaD there are non-specific patterns of hypoperfusion (Mortimer et al., 2013). White mater lesions can be detected, if the infarction is large enough, by both methods but an incomplete infarction may be undetectable. Also changes in white matter can occur in normal aging as well as in both DAT and VaD therefore these methods are not useful in terms of differential diagnosis between DAT and VaD (Nagata et al., 2007) although Meyer et.al. (2007) argues that MRI can even identify the existence of subtypes of MCI that are prodromal for different subtypes of dementia and as such is a useful tool.

Complicating differential diagnosis further is mixed dementia. This is where individuals meet the criteria for both VaD and DAT. As noted above there are similarities between the two disorders and it can be difficult to make a clear distinction between the two (Korczyn, Vakhapova, & Grinberg, 2012). Mixed pathologies are believed to occur as frequently as pure DAT pathology (Schneider, Arvanitakis, Leurgans, & Bennett, 2010). There is ongoing debate as to whether mixed dementia or VaD are disorders as such or whether VaD is secondary to DAT pathology (Meguro, Tanaka, Nakatsuka, Nakamura, & Satoh, 2012). However, excluding participants with a mixed dementia presentation still demonstrated greater executive function impairment for those with VaD as opposed to those with DAT (Yoon, Shin, et al., 2013).

Table 5

Features of Vascular Dementia and Alzheimer's Disease

Feature	Vascular Dementia	Alzheimer's Disease
Onset	Sudden or gradual	Gradual
Progression	Slow, stepwise fluctuation	Constant insidious decline
Neurological findings	Evidence of focal deficits	Subtle or absent
Memory	Mildly affected	Early and severe deficit
Executive function	Early and severe	Late
Dementia type	Subcortical	Cortical
Neuroimaging	Infarcts or white matter lesions	Normal; hippocampal atrophy
Gait	Often disturbed early	Usually normal
Cardiovascular history	Transient ischemic accidents, strokes, vascular risk factors	Less common

(From Roman, 2003)

2.5   Summary

Pathological aging of the brain results in deficits far exceeding any that occur during normal aging. Two of the most common types of dementia, DAT and VaD are progressive in nature and often cause significant disruption to the lives of older adults. Early diagnosis is important as, with no cure available, delaying the progression of the disease is currently the best treatment option. Beneficial treatment outcomes have been modest so far but appear to have greater therapeutic value in the early stages of the disease. The similar presentations and overlapping pathologies of VaD and DAT can make for difficult differential diagnosis but it appears that the domain of memory may discriminate between the two. Memory and its relationship to VaD and DAT is the focus of the next chapter.

Chapter Three

Memory

It is commonly believed that memory declines with age but not all types of memory are susceptible to the decrements associated with normal aging (Anstey & Low, 2004; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997). Long term memory containing accumulated knowledge and expertise known as 'crystallised' abilities are resistant to aging and generally are not affected in the early stages of dementia. However, "fluid" abilities such as processing speed and problem solving that are dependent on short term memory storage for the processing of information are susceptible to the effects of aging. It is clear that memory is affected early or even prior to the onset of DAT and during the course of VaD. Memory impairment can be frustrating for older people particularly when it impacts on day-to-day functioning. Even in healthy older adults, deficits in episodic and prospective memory are strong predictors of problems in instrumental activities of daily living (Woods, Weinborn, Velnoweth, Rooney, & Bucks, 2012). Severe memory impairment reduces independence and restricts the ability of older people to live independently. Maintaining the ability to live independently is often a very real concern for older people and prospective memory is critical to the retention of personal independence. Remembering to turn the cooking element off, or putting the rubbish out on rubbish day or remembering an appointment all rely on prospective memory. Loneliness can also be an issue for older people and prospective memory is integral to maintaining friendships and social relationships through remembering to phone or meet with friends or through acknowledging special occasions such as birthdays. Prospective

memory is not an independent entity; it interacts with other memory forms. While

researchers have examined the relationship between prospective memory and episodic

memory, there appears to have been no examination of the relationship of either object-

location memory or recollection memory to prospective memory. These need to be

explored and will be the focus of this study.

3.1   Working memory

Working memory is a system that provides temporary storage for the manipulation of

information before it enters long term memory. According to Baddeley's (2001)

multicomponent model (Figure 1), working memory consists of four components: central

executive for the control of attentional processes, visuospatial pad for visual and spatial

information manipulation and storage, phonological loop for auditory information

manipulation and storage and the episodic buffer for the integration of information from

the other components and long term memory (Baddeley, 2001). Attentional processes

are imperative to the effectiveness of working memory and attention is crucial to the

encoding of memories. Attentional processes include sustained attention, selective

attention and divided attention. While sustained attention tends to remain stable in aging

the latter two gradually decline with normal aging. Sustained attention is affected by

dementia; in the early stages of VaD and the later stages of DAT. Selective attention and

divided attention are compromised in the mild to moderate stages of both dementias

(McGuinness, Barrett, Craig, Lawson, & Passmore, 2010). Visual working memory is

affected by aging and visual working memory performance in older people is correlated

with processing speed. Slowed encoding and rehearsal speed resulting in poorer recall

has been suggested as the reason for the reduction in performance (Brown & Brockmole, 2012).

Working memory is also involved in PM performance although not all studies have agreed on an association between working memory and PM. A number of reasons have been given for a lack of association including the use of measures lacking in sensitivity and restricted ranges in PM performance (Rose, Rendell, McDaniel, Aberle, & Kliegel, 2010). However in a study addressing those shortcomings, having good working memory function was clearly associated with preserved prospective remembering (Rose et al., 2010). Working memory is seen to involve similar but different processes to PM with working memory implicated when attentional resources are used but not when spontaneous retrieval is involved (Brewer, Knight, Marsh, & Unsworth, 2010; Rose et al., 2010).

Figure 1

Baddeley's Model of Working Memory
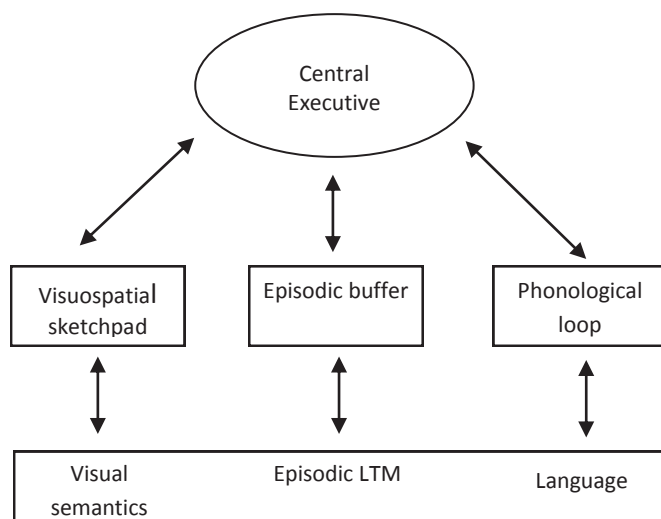
(From Baddeley, 2001)

3.2   Episodic memory

Episodic memory is the memory for personal experiences. Episodic memory is comparable to an autobiography containing personal information about experiences, achievements and information that has been gained through personal experience including when and where each occurred (Weiten, 2004). Systems within episodic memory encode, store and retrieve information. Wide networks of brain areas are utilised in episodic memory including the temporal frontal lobes, hippocampus, associated temporal-parietal areas and prefrontal cortex; areas that are also susceptible to the effects of DAT (Fletcher, Shallice, Frith, Frackowiak, & Dolan, 1998; Remy, Mirrashed, Campbell, & Richter, 2005). The hippocampus is involved in encoding while the frontal lobes are involved during both encoding and retrieval. Encoding is therefore problematic for people with DAT. Impairment of episodic memory has also been identified in the preclinical phase of VaD (Laukka et al., 2004). Difficulties in storage and retrieval have also been suggested as an explanation for episodic memory issues in DAT (Vanderploeg et al., 2001). The prefrontal cortex is involved in retrieval of the context of memories but plays only a minor role in recollection of the content of memories (Spencer & Raz, 1995).

3.3   Object-location memory

Object location memory is described as a special type of episodic memory concerned with the binding of identity and location information. Postma, Kessels & Asselen (2008) have

broken down object-location memory into three parts consisting of object processing, spatial-location processing and object to location binding. Therefore information about the object itself is combined with information regarding the location of the object. Object processing is thought to be reliant on temporal lobe structures; spatial processing being reliant on the parietal cortex and binding objects to locations the domain of the hippocampus (Piekema, Kessels, Mars, Petersson, & Fernandez, 2006; Postma et al., 2008; van Asselen et al., 2009). More specifically encoding and retrieving of spatial locations is associated with the precuneus (Frings et al., 2006; Krause et al., 1999; Mottaghy et al., 1999). There is also evidence of the involvement of other brain areas such as the inferior and medial cortex, inferior frontal cortex and the superior parietal regions in object location memory (Ramsoy et al., 2009). Clearly the areas of the brain involved in object-location memory are also implicated in DAT and MCI (Hampstead, Stringer, Stilla, Amaraneni, & Sathian, 2011).

Misplacing objects is a common memory complaint by older people and this is evidenced by object-location memory abilities declining with age (Kessels, Hobbel, & Postma, 2007; Meulenbroek et al., 2010). Few studies have examined the relationship between DAT and object-location memory. The findings of those studies that have examined the relationship show deficits in object-location memory performance, which is not surprising due to the sensitivity of the hippocampus to DAT. Significant deficits are evident in both memory for the location of an object and memory for the actual object although object memory shows greater impairment than location memory (Brandt, Shpritz, Munro, Marsh, & Rosenblatt, 2005) demonstrating the deficits in the binding of object to location in the hippocampus. No significant differences were identified between VaD and DAT

object-location memory tasks although it had been suggested that due to white matter

changes participants with VaD would experience greater difficulty in completing the tasks.

The small sample size and large variances were suggested as contributing factors to the

lack of significance in the results (Bucks & Willison, 1997). Differences have been

identified though between DAT, MCI and healthy older adults with DAT performing worse

than MCI and both groups performing worse than the healthy older adults (Kessels,

Rijken, Joosten-Weyn Banningh, van Schuylenborgh-Van, & Olde Rikkert, 2010).

3.4   Semantic memory

Semantic memory is the memory for facts, names and general knowledge. As such

semantic memory is related to crystallised intelligence which tends to be reasonably

robust against the effects of aging (Berk, 2007). Information retained in semantic

memory is not linked to the time that the information was learned or the place in which it

was learned. Knowing that Wellington is the capital of New Zealand is not connected to

the date and place that you learnt the information. Semantic memory is comparable to

an encyclopaedia (Weiten, 2004). In healthy older people grey matter volume correlates

positively with the preservation of semantic memory (Taki et al., 2011). In MCI,

difficulties in the acquiring of new information and the updating of existing information

held in semantic memory have been noted (Seidenberg et al., 2009). The variability of

semantic memory impairment in the early stages of DAT likely reflects the individual

differences in the decrease in grey matter as the disease progresses (Graham et al.,

2004). In comparison though, in an early stage VAD group, 80% of participants in one

study were significantly impaired in semantic memory (Graham et al., 2004). Due to the

fast rate at which information is forgotten cues are less likely to aid recall.   Also noted in the same study was greater impairment in executive/attentional function and visuospatial function in the VAD group in comparison to the DAT group. Vascular dementia is associated with difficulties in retrieval from semantic memory while the difficulties in advanced DAT are associated with degradation of semantic memory. As yet there is no consensus over the usefulness of cues for memory retrieval. In tests of semantic memory a prompt was found to benefit people with advanced DAT and those with cortical vascular dementia. Performance on semantic memory measures can differentiate between older healthy adults and those with dementia but not between VaD and DAT (Vanderploeg et al., 2001).

3.5   Recognition memory

Recognition memory is a model of retrieval that involves the ability to decide if the information or event has been encountered previously (Baddeley, Eysenck, & Anderson, 2009) whether it be held in episodic or semantic memory. The Dual Process Model suggests that the independent processes of recollection and familiarity support recognition memory (Brown & Aggleton, 2001; Jacoby, 1991; Sauvage, Beer, & Eichenham, 2010; Serra et al., 2010; Yonelinas, 2002). Recognition memory involves identifying and judging whether an event has occurred previously. Recollection; one of the two underlying processes, entails the conscious retrieval of the context of a prior event or in other words a form of cued recall. The other underlying process; familiarity, can be described as a sense or feeling of knowing of the prior event. It would appear that familiarity is the first process that occurs – "I know I've met you before but I don't

remember the specific event", followed by a conscious memory search for the relevant information resulting in recollective matching and recalling the specific event of previously meeting that person (Brown & Aggleton, 2001). The two dissociative processes are supported by two different parts of the medial temporal lobe; the hippocampus is integral to recollection while the perirhinal cortex is integral to familiarity (Bowles et al., 2007; Greve, Evans, Graham, & Wilking, 2011). These two areas work together to form a recognition memory system with each contributing a different element to the recognition process (Brown & Aggleton, 2001; Serra et al., 2010; Skinner & Fernandes, 2007).

There is strong evidence that hippocampus damage impairs recollection while familiarity remains relatively unimpaired (Aggleton et al., 2005; Baddeley, Vargha-Khadem, & Mishkin, 2001; Bastin et al., 2004; Holdstock, Mayes, Gong, Roberts, & Kapur, 2005). It would then stand to reason that people with DAT will do better on tests of familiarity than on tests of recollection. Diana, Yonelinas & Ranganath (2007) however, argue that following a review of MRI studies there are actually three components interacting not just two forming the basis of the 'binding of item and context' (BIC) model. The hippocampus combines item and contextual knowledge that is provided via the encoding and retrieval of contextual knowledge by the parahippocampal cortex and via the perirhinal cortex that encodes and retrieves item specific knowledge assisting familiarity. Therefore, they argue, the 'what' from the perirhinal cortex and the 'where' from the parahippocampal are bound together by the hippocampus. The BIC model has gained support from other researchers (Davachi, 2006; Hannulah, Libby, Yonelinas, & Ranganath, 2013; Howard, Kumaran, Olafsdottir, & Spiers, 2011; Hunsaker, Chen, Tran, & Kesner, 2013).

A review by Skinner & Fernandes (2007) of 33 studies also noted increased activation of the right dorsolateral prefrontal cortex and the parietal lobe (BA7) with both recollection and familiarity-based responses. Recollection responses showed increased activity in the bilateral anterior frontal (BA10) region, an area also associated with prospective memory. Activation of the inferior parietal lobe occurred with recollection but not familiarity-based responses while the lateral prefrontal cortex is important for item recognition in familiarity, but not recollection (Aly, Yonelinas, Kishiyama, & Knight, 2011). Also of note recollection uses episodic memory but it appears that familiarity based memory is not linked to episodic memory (Aggleton & Brown, 2006).

Of the two processes involved in recognition memory, the recollection memory component is susceptible to age related changes while the familiarity memory component remains stable (Algarabel et al., 2012; Howard, Bessette-Symons, Zhang, & Hoyer, 2006; Parkin & Walter, 1992; Yonelinas, 2002). Deficits in recognition memory in DAT have been identified using MRI (Remy et al., 2005). To a lesser extent recognition memory is also impaired in VaD due to retrieval difficulties (Yuspeh et al., 2002). It appears that both recollection-based and familiarity-based components of recognition memory are impaired in DAT (Hudon, Belleville, & Gauthier, 2009; Westerberg et al., 2006) however if as noted above, damage to the hippocampus affects familiarity more than recollection, then people with DAT are likely to show greater deficits in familiarity-based memory rather than recollection-based memory. Researchers also considered whether impairment would also be evident in MCI. This was confirmed with both recollection and familiarity found to be impaired in MCI when compared with age-

matched controls (Algarabel et al., 2009; Algarabel et al., 2012; Ally, Gold, & Budson, 2009; Wolk, Signoff, & DeKosky, 2008) although there has not been consensus, with some studies finding no impairment of familiarity in MCI (e.g., Hudon et al., 2009; Serra et al., 2010; Westerberg et al., 2006). Familiarity-based memory has boldly been suggested as a biomarker for brain changes in prodromal and preclinical DAT (Wolk, Mancuso, Kliot, Arnold, & Dickerson, 2013). Recognition memory is a factor for successful prospective remembering in recognising prospective memory cues. Recognition memory and prospective memory are thought to influence each other with recognition memory having been identified as a predictor of prospective memory performance (Cherry et al., 2001).

3.6   Retrospective memory

 Retrospective memory is the memory for past events. Generally cues or instructions prompt the recovery of information from retrospective memory. For example, being asked by another person which school you attended as a child. Retrospective memory also covers autobiographical, episodic and semantic memories as well. Retrospective memory is impaired in VaD and DAT including the retention of information over short intervals. Difficulties with the consolidation of episodic memories are believed to be a contributing factor (Livner, Laukka, Karlsson, & Backman, 2009). Retrospective memory relies on the medial temporal lobe. A number of studies have noted that retrospective memory shows greater impairment from aging and dementia than prospective memory (Livner, Berger, Karlsson, & Backman, 2008). Also the contribution of retrospective memory to PM performance is not deemed sufficient enough to account for impairment in PM (Thompson, 2010).

3.7   Prospective memory

Prospective memory (PM) is the memory for future intentions; remembering to carry out an action at a point in the future (McDaniel, Guynn, Glisky, Rubin, & Routhieaux, 1999). Prospective memory tasks fit the following criteria: the intended action is not to be carried out immediately; the task is imbedded in an ongoing activity; there is a limited window in which the response initiation can occur; response execution needs to occur within a limited timeframe and a conscious intention must be formed (McDaniel & Einstein, 2007). Prospective memory is involved in many day to day activities such as remembering to pick up the dry cleaning on the way home. Given the prevalence of prospective memory tasks in everyday life this form of memory is particularly important in maintaining independence of daily living particularly for the elderly. In spite of this, PM has received considerably less research attention than retrospective memory (Jones et al., 2006).

Prospective memory incorporates two components: a prospective component - remembering the intention to perform a specific action (e.g., remembering to make a phone call before work) and a retrospective component - remembering the content of the intended action (e.g. remembering that the phone call is to your mother to wish her happy birthday). Therefore not only does one need to remember the action *that* is to be carried out but also remember to carry out the action at the *relevant time/place* (Einstein & McDaniel, 1990). Of the two, remembering to carry out the action at the appropriate time or place is generally the more difficult.

Even though PM has a retrospective component, there are differences between PM and

retrospective memory. In particular, through factor analysis the two have been found to

be only weakly related (Uttl, Graf, Miller, & Tuokko, 2001). Similar areas of the brain are

involved in PM and retrospective memory but the level of involvement differs between

the two (Okuda et al., 2003) each drawing from different regions of the brain. Zhou et al.,

(2012) have suggested that traditional retrospective memory may be quite different from

the PM retrospective component following a study examining the PM components that

found the retrospective component to be preserved in MCI. In contrast to the previously

reported declines of traditional retrospective memory in MCI (Jones et al., 2006).

Prospective memory then, while separate, still needs to be considered in connection with

retrospective memory.

There are three types of PM task: time-based, event-based and habitual. Time-based

tasks require an action to be carried out at a particular time in the future. Event-based

tasks require an action to be carried out in response to an external cue which prompts

the retrieval of the intention from memory. Time-based and event-based tasks both

involve remembering to carry out the intended action (Einstein & McDaniel, 1990) with

the clear distinction between them being in terms of cue – i.e., the lack of a cue in time

based PM tasks as opposed to being in response to an external cue in event based tasks.

Remembering in time-based PM tasks then is thought to be reliant on internal self-

initiated resources. The third type of task is habitual which require an action to be

performed on a regular basis and can incorporate elements of either time-based or event-

based tasks. Regular reoccurring routine tasks are generally the easier to remember and are very common in daily living (Rendell & Craik, 2000).

3.7.1   Multi process theory

One major theory of PM that has gained support is the multi process theory. Remembering of intentions often occurs without an external cue prompting retrieval. There is no verbal request to recall previously learnt information as can occur for remembering past events. Instead attention somehow is switched from the task at hand to thinking about the intended action and to performing it. For this to occur McDaniel & Einstein (2000) propose that not only is there more than one process involved in the remembering of intentions but also that prospective remembering occurs through either strategic or attention-demanding processes. Multi process theory suggests that remembering may occur through automatic processes or through voluntary monitoring using attentional resources, by individuals or indeed through a combination of both where an automatic process may initiate the remembering but then be followed by a controlled search of memory for the full intention (McDaniel & Einstein, 2000). Therefore spontaneous automatic retrieval of intentions can also occur without the involvement of preparatory attentional processes (Harrrison & Einstein, 2010; Knight et al., 2011; Scullin & Einstein, 2010).

A number of relatively automatic processes are thought to mediate PM retrieval with or without a target event stimulating awareness of an intention. These include an attentional system that responds to salient or unfamiliar stimuli and several automatic memory-based processes that support the retrieval of prospective intentions in a more

spontaneous manner in the absence of strategic monitoring (McDaniel & Einstein, 2000).

These authors argue that particular factors determine the method of retrieval and degree

to which prospective remembering relies on automatic versus attention demanding

processes.

The multi process theory suggests that two brain networks are involved in prospective

remembering; one involved with spontaneous retrieval and the other with effortful

attention (Gordon, Shelton, Bugg, McDaniel, & Head, 2011; McDaniel, Shelton, Breneiser,

Moynan, & Balota, 2011). The network supporting effortful attention was identified by

fMRI and PET scanning to involve the anterior prefrontal region, parietal and medial lobe,

the dorsolateral prefrontal region and the lateral parietal region (Burgess, Quayle, & Firth,

2001; Reynolds, West, & Braver, 2009). The medial temporal, particularly the

hippocampus is thought to be the primary region supporting spontaneous retrieval of

prospective memory intentions given the involvement of the hippocampus in episodic

and spatial memory (Gordon et al., 2011). Tam & Schmitter-Edgecombe (2013) argue

that identification of non-focal cues uses both effortful attention and spontaneous

retrieval processes.

 Prospective memory involves delayed intentions that need to be maintained until their

appropriate execution. Maintaining an intention activated the rostral prefrontal cortex

particularly BA 10 bilaterally, the precuneus bilaterally, the right parietal lobe and the

right lateral prefrontal cortex in studies by Benoit, Gilbert, Frith & Burgess (2012) and

Burgess et al., (2001). The execution of an intention showed increased activity in the

thalamus and reduced activity in the right dorsolateral prefrontal cortex (Burgess et al.,

2001). Momennejad & Haynes (2012) investigated how the brain stores the 'what' and 'when' of time-based prospective memory tasks, concluding that information about the content of the delayed intention being maintained is encoded in the dorsomedial prefrontal cortex as well as being held there. The content of the intention was then found in the ventrolateral and the lateral prefrontal cortex during retrieval. The 'when' of the timing for the intention to be carried out was found during maintenance in the medial and bilateral prefrontal cortex and during retrieval in the lateral and dorsolateral prefrontal cortex. Okuda et al., (2007) looked at differences in brain activation between event and time-based PM tasks. In both event and time-based tasks activation was seen in the anterior medial frontal lobe, the right superior frontal gyrus and the anterior cingulated gyrus however there was greater activity in the right superior frontal gyrus during time-based pm tasks.

3.7.2   Prospective memory and aging

The relationship between age and PM decline has captivated researchers since Craik (1986) first noted the presence of an age paradox in PM. Since then studies of adult age differences in PM continue to produce inconsistent results with some studies finding age effects in PM (Huppert, Johnson, & Nickson, 2000; Smith & Bayen, 2006; Robert West & Bowry, 2005; Zeintl, Kliegel, & Hofer, 2007) while others have found no PM age effects (Einstein & McDaniel, 1990; Kvavilashvili & Fisher, 2007; Vogels, Dekker, Brouwer, & Jong, 2002).

As a result attention was focused on the nature of the PM task in an attempt to explain these inconsistencies in relation to aging.   Craik (1987) theorised that when there are

minimal environmental supports in the form of cues and context, remembering requires self initiated retrieval processes to be used by the rememberer and these self initiated processes are susceptible to the effects of aging. He argued that age related changes in memory were due to increasing difficulties with the execution of self initiated actions as people aged and processing resources declined. However Einstein & McDaniel (1990) found no evidence of aging disrupting self initiated retrieval processes in prospective memory activities. An added challenge in researching PM is identifying if performance deficits are due to the prospective and/or retrospective components of PM. Evidence points towards the prospective component being affected to a greater extent by aging than the retrospective component of PM (Cohen, West, & Craik, 2001; West & Craik, 2001).

In time-based laboratory PM tasks, an age deficit of significant size has been found through meta-analysis (Henry, MacLeod, Phillips, & Crawford, 2004). These results support the view that age-related declines in self-initiated retrieval resources negatively affect the performance of older adults in time-based PM tasks compared to younger adults. One possible reason is that older adults adopt less effective monitoring strategies, for example younger adults have been observed increasing their clock monitoring behaviour just prior to the target time whereas there was not a corresponding increase in monitoring frequency by older adults (McDaniel & Einstein, 2007). In a laboratory study by Mantyla, Missier & Nilsson (2009) older adults monitored the clock more frequently than younger adults but the focus on clock monitoring came at a cost to performance on the primary activity.

A criticism of outcome measures of time-based PM tasks has been the use a single measure to ascertain purely the presence or absence of PM deficits. This criticism could be equally applied to event-based PM tasks. Mantyla, Missier & Nilsson (2009) believe that by using multiple outcome measures that measure monitoring frequency, accuracy of response and performance on the primary task a pattern can be seen of benefits and costs. They confirmed their view finding that when older adults increased monitoring frequency, response accuracy increased but with a corresponding decrease in performance on the primary tasks.

It has been argued that time-based prospective remembering cannot be truly assessed in a laboratory setting as the time frames for tasks are short, usually delay intervals of hours rather than days. It has been suggested in that situation that PM tasks are unlikely to leave the participant's awareness and could then become a monitoring task rather than a true assessment of prospective memory (Kvavilashvili & Fisher, 2007). Therefore deficits thought to be in time-based PM may actually be more reflective of a deficit in time monitoring instead (Park et al., 1997).

The age-related patterns in event-based PM are similar to those found in time-based PM (McDaniel & Einstein, 2007) except many studies have found older adults to perform similarly or better than younger adults specifically in naturalistic situations, rather than the large age-related differences found with time-based PM tasks (Rendell & Craik, 2000; Schnitzspahn, Ihle, Henry, Rendell, & Kliegel, 2011). Success in event-based PM performance was thought to be dependent on the target event triggering the memory for the action that was to be carried out (Einstein & McDaniel, 1990). However, recognition

of the target cue was later found to only account for 10% of variance in prospective

memory performance in a study by Reese & Cherry (2010). The interaction between age

and event-based PM performance has perplexed researchers in a similar way to those

researchers investigating time-based PM. Surprisingly the same three answers have

emerged from both sets of researchers. Firstly the suggestion that the age-related

difference in PM is due to the degree of difficulty of cognitive task demands (McDaniel &

Einstein, 2007; van der Berg, Kant, & Postma, 2012). Secondly intentions are maintained

by sacrificing performance on an ongoing activity and thirdly PM performance is affected

by the degree to which the retrieval of the intention is self-initiated or spontaneous

(McDaniel & Einstein, 2007). Therefore looking towards time-based and event-based PM

tasks to explain age-related differences in PM is too simplistic and neither type of task has

the degree of impact on PM performance originally envisioned by researchers. In fact

there were no significant differences when time-based PM was compared to event-based

PM in a meta-analysis (van der Berg et al., 2012).

The suggestion that difficulty of the task has an impact on PM performance is not new

and recent research has provided confirmation that as the cognitive task becomes more

difficult age differences in PM become more noticeable (McDaniel & Einstein, 2007;

Rendell, McDaniel, Forbes, & Einstein, 2007). Additionally the degree to which a task

relies on automatic versus self-initiated processing appears more likely to have an impact

than whether a task is time-based or event-based (van der Berg et al., 2012). Also task

difficulty can be affected by whether a PM cue is focal or non focal. A cue is focal when it

is part of performing the ongoing activity, for example remembering to turn an element

down when the contents of a pot start boiling. Prospective memory tasks involving non-

focal cues are seen to be more difficult to remember as the cues are either not embedded in the ongoing activity or the ongoing task does not focus processing on the features of the cue (Kliegel, Jager, & Phillips, 2008; McDaniel & Einstein, 2000; McDaniel et al., 2011; Uttl, 2011) for example remembering to make a phone call about car repairs when you finish having a shower.

In laboratory based studies of event based PM tasks where older participants participated in both focal tasks and non focal tasks, performance declined for non focal tasks when compared to focal tasks (Cherry et al., 2001; d'Ydewalle, Luwel, & Brunfaut, 1999; Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995; Rendell et al., 2007). Non-focal cues are also not detected as often as focal cues (Henry et al., 2004; Kliegel et al., 2008). Age related effects were evident in focal tasks but not to the level of the effects found with non-focal tasks (Kliegel et al., 2008). The difficulty with non-focal tasks has been attributed to the reliance on declining attentional resources to boost detection of cues (Brewer et al., 2010). It appears though that PM performance is affected by age regardless of the task focality but to a varying degree.

Kavavilashvili & Fisher (2007) proposed that in naturalistic settings chance encounters with related cues, between the time the intention is formulated and the intention being carried out triggers the retrieval of the intention. To support their view Kavavilashvili & Fisher (2007) conducted a study using a naturalistic time-based PM task involving participants having to remember to make a single phone call to the experimenter at a specified time seven days later. In addition to keeping a diary over the week recording every occurrence that they rehearsed or recalled their intention to make the phone call,

participants also noted what they had been doing at the time of the recall and any trigger that brought the intention to mind. This study highlighted a possible explanation for the age paradox in prospective memory. Older adults were found to report higher levels of motivation both before and after task completion than younger adults in a naturalistic setting. This effect has been confirmed in more recent studies of age and motivation in naturalistic settings and while younger adults respond well to incentives older adults tend to be more conscientious about task completion even with naturally occurring PM tasks (Aberle, Rendell, Rose, McDaniel, & Kliegel, 2010; Ihle, Schnitzspahn, Rendell, Luong, & Kliegel, 2012; Jeong & Cranney, 2009).

Motivation may be influenced by task importance and task importance has been highlighted as a possible age–related moderator of PM task performance. By using everyday PM tasks in a naturalistic setting, older adults performed higher than younger adults in tasks of low to medium importance and equally as well as younger adults on PM tasks of high importance (Ihle et al., 2012). In addition to higher levels of motivation older adults were more inclined to be involved in familiar relatively habitual activities that were not highly cognitively demanding. The cognitive demands of the ongoing tasks have previously been identified as a factor in age-related differences in PM performance. While older people may also have higher motivation than younger people in laboratory situations the unfamiliarity of tasks within a laboratory setting may place a higher cognitive demand on older people with a resultant drop in performance. Therefore the use of familiar and undemanding activities in the laboratory may eliminate age effects (Kvavilashvili & Fisher, 2007).

Bailey, Henry, Rendell, Phillip & Kliegel (2010) have extended this line of thought suggesting that it is the naturalistic nature of the ongoing tasks that makes the difference rather than the setting. Using an experimenter-generated task in a naturalistic setting resulted in poor performance of older adults similar to previous findings in laboratory settings while the same group performed well when the task itself was naturalistic. When a naturalistic PM task was used in both a laboratory and a naturalistic setting, cognitively impaired older adults performed comparatively in both settings (Will et al., 2009). When the PM task is naturalistic older adults can outperform younger adults in both time and event-based PM tasks but this situation is reversed when laboratory tasks are used (Niedzwienska & Barzykowski, 2012). These findings highlight a possible solution to the age paradox.

3.7.3 Prospective memory, mild cognitive impairment and dementia

As previously noted although PM has been shown to be affected by aging, the age related decline on focal tasks in healthy adults is described as minimal (Einstein & McDaniel, 1990; Rendell & Craik, 2000) while a significant decline in performance occurs when the task is non-focal (Kliegel et al., 2008) compared to younger adults. Prospective memory performance has also been examined in people with MCI and those with dementia with declines evident in both groups (Thompson, 2010). Prospective memory in older adults with mild dementia showed large decrements in performance compared to healthy adults (Duchek, Balota, & Cortese, 2006; Huppert et al., 2000; McDaniel et al., 2011; van der Berg et al., 2012) and older adults with MCI (Troyer & Murphy, 2007). These effects have also been observed in preclinical DAT (Jones et al., 2006). These findings have led to the

suggestion that PM failure is an early indicator of MCI or dementia (Blanco-Campal, Coen, Lawlor, Walsh, & Burke, 2009).

The nature of the PM cue as focal or non-focal has been highlighted for its effect on the performance of healthy older adults. Healthy older adults tend to perform lower on non-focal PM tasks in comparison to focal PM tasks (Park et al., 1997; Rose et al., 2010). However, non-focal PM cues discriminate better than focal PM cues with healthy older adults outperforming individuals with MCI (Blanco-Campal et al., 2009; Tam & Schmitter-Edgecombe, 2013) indicating that non-focal cues may also negatively affect PM performance in DAT where MCI has preceded DAT. McDaniel et al., (2011) argues that this may not be useful as an indicator as robust deficits have been noted in studies on non-focal PM tasks with healthy older adults. Blanco-Campal et el., (2009) puts these findings down to the extra load placed on strategic attentional processes by non-focal cues that then highlight executive dysfunction in performance. Attentional processes, specifically attention control are critical to working memory and low working memory capacity reduces the ability to perform well on non-focal PM tasks (Brewer et al., 2010). As working memory is compromised by DAT, performance on non-focal PM tasks is also likely to be compromised. Focal cues are thought to be reliant on spontaneous retrieval processes that involve the medial temporal lobe, particularly the hippocampus. As previously noted hippocampal decline is common in Alzheimer's disease. Spontaneous retrieval processes appear to be affected in the early stages of Alzheimer's disease with focal prospective memory tasks proving more difficult for people with early DAT than healthy older adults (McDaniel et al., 2011). The difference was put down to reliance on dysfunctional spontaneous retrieval processes. Compared with healthy adults PM

performance is negatively affected in MCI but to a lesser degree than in dementia.

Difficulties appear to be as a result of failures of the retrospective component of PM as a

number of participants who did not carry out the PM task had no recall of the task

(McDaniel, 2011). What is not clear is if focal PM tasks can discriminate between DAT and

VaD.

Prospective memory tasks are often initiated by the presence of a cue. The sight of a

clock showing it is nearly 3pm can be a cue for remembering to pick the children up from

school. The sound of rain can be a cue for remembering to take an umbrella.

Researchers have often used prompts if participants have not noticed a PM cue. Prompts

have been found to benefit both healthy older people and those with MCI. People with

MCI required more prompts but once prompted were able to carry out tasks similar to

healthy older people (Seelye, Schmitter-Edgecombe, Cook, & Crandall, 2013). It has

already been suggested that due to encoding difficulties in DAT resulting in rapid

forgetting, cues are of limited benefit (Desmond, 2004; Vanderploeg et al., 2001). It

would therefore stand to reason that being provided with a prompt is unlikely to increase

PM performance for this group. Those people with VaD on the other hand are thought to

benefit from cues (Erkinjuntti et al., 2000) and therefore are likely to benefit also from

prompts. This study will investigate the role of the prompts in the Rivermead Behavioural

Memory Test (RBMT) PM subtests with DAT and VaD.

As discussed above the frontal regions of the brain are significantly important for PM

performance, particularly for maintaining an intention. Prospective memory also relies

on executive functioning therefore maintaining intentions may be difficult for people with

VaD as the disease compromises the frontal brain regions (Livner et al., 2009). Prospective memory functioning relies on episodic memory and executive functioning. Given that episodic memory is significantly impacted on by DAT and executive functioning by VaD, PM functioning will be affected by either dementia. Participants with VaD are likely then in this study to have difficulty in the maintaining of the intention whereas participants with DAT are likely to have difficulty in the encoding of the intention. A prompt may be helpful for people with VaD to aid them in retrieving the intention whereas a prompt would not be of any benefit to people with DAT if the intention was never encoding correctly in the beginning therefore leaving nothing to retrieve.

There appears to be very little research into the effects of gender on prospective remembering in dementia. Limited research into other areas of memory suggests greater impairment in visuospatial memory in females with dementia compared to males with dementia (Beinhoff, Tumani, Brettschneider, Bittner, & Riepe, 2008). Xing et al., (2012) did not find any significant gender differences in visuospatial ability and verbal memory in VaD. Glass (1998), however, had noted gender differences on verbal memory in dementia but not for PM. In another study that also examined gender differences in PM, there was no effect for gender on a laboratory-based PM task or on an event-based PM naturalistic task but older females did however perform better than older males on a time-based PM naturalistic task (Hering, Cortez, Kliegel, & Altgassen, 2013). As the authors suggest the task of preparing breakfast was probably one of higher familiarity to women than men though. In another study older females self-rated naturalistic PM tasks to be of higher importance than older men did (Penningroth & Scott, 2013). This study will also investigate if there is an effect for gender on the RBMT PM subtests.

3.7.4 Prospective memory, depression and dementia

Dementia and depression can present in similar ways. PM is impaired by dementia but does depression also impair PM performance? In younger adults, depressive symptoms were found to have a negative impact on PM task performance in a laboratory setting (Rude, Hertel, Jarrold, Covich, & Hedlund, 1999). In a naturalistic setting the intention as such was not forgotten but depressed participants had difficulty executing the intention on time (Jeong & Cranney, 2009). Comparing the performance of older adults to younger adults may not be useful as older adults have already been shown to have higher motivation to complete PM tasks. Also research into the effects of depression on PM are limited and not all studies support PM being negatively affected by depressive symptoms (Harris & Menzies, 1999). Even fewer studies have been published on the relationship between depression, PM and aging. A 2008 study by Livner, Berger, Karlsson & Backman appears to be the first to investigate this relationship. The PM test took the form of each participant being asked to remind the tester to make an important phone call at the end of all testing, 62 minutes later. No association was found between depressive symptoms and PM performance in older adults although retrospective memory was significantly impaired (Livner et al., 2008). In a study by Albinski, Kliegel, Sedek & Kleszczewska-Albinska (2012) subclinical depression appeared to have a positive effect on PM performance. PM performance on event-based tasks was not affected by sub clinical depression and the PM performance of sub clinically depressed older adults actually increased on time-based tasks. Overall it appears that the PM of older adults with dementia is not adversely affected by depressive symptoms and is unlikely to impact on

the testing of PM in older adults. Testing of PM may provide a useful tool to discriminate between dementia and depression.

3.7.5   Measurement of prospective memory

While there are a number of commonly used measures of memory e.g., the various editions of the Wechsler Memory Scale; Mini Mental State Examination; Cognistat; Addenbrooke's Cognitive Examination, none of these include a measure of PM. In general these measures have been criticised for lacking in ecological validity (Makatura, Lam, Leahy, Castillo, & Kalpakjian, 1999) as performance on these tests may not relate to a person's functioning in day to day activities. As such they are unlikely to accurately reflect the memory difficulties of most concern to the individual. A call has been made for a brief reliable and valid assessment tool for PM that can be used in clinical practice (Blanco-Campal et al., 2009; Thompson, 2010) but as of yet the call has not been answered. An earlier version of the WMS (WMS-R) was found to be only slightly more accurate with classification of mild and moderate memory impairment than the Luria Nebraska Neuropsychological Battery Memory Scale (Makatura et al., 1999), neither of which measured PM or had much ecological validity. Of the few standardised measures of PM, one, the RBMT has been touted for its ecological validity. When compared it was not found to differ significantly from the WMS-R in relationships to estimates of everyday memory functioning. Nor was there an advantage in using the two tests together (Koltai, Bowler, & Shore, 1996).

Prospective memory can be difficult to assess due to the nature of its make up having a component of retrospective as well as prospective memory. Adding to measurement

difficulties is that as stated earlier, PM is not a single memory system instead integrating a number of memory systems including semantic and visuo-spatial or episodic memory (Efklides et al., 2002). The majority of research studies into PM have been based in the laboratory in order for control to be exerted over the PM task context and use of external aids (Einstein & McDaniel, 1990). At one stage use of external aids such as calendars, alarms, notes to support remembering was thought to explain age effects between older and younger people, however this has been proven to not be the case with the frequency and effectiveness of external aids similar for both groups (Aberle et al., 2010; Freeman & Ellis, 2010; Ihle et al., 2012). Thompson (2010) also highlighted the difficulty in assessing PM when there are few standardised measures of the construct and brief screening tools for cognitive impairment that do not assess PM.   Due to time constraints in clinical practice unstandardised brief measures are becoming increasingly more commonly used in clinical assessment (Thompson, 2010). The restricted range of scores that can be achieved with many of the PM tasks commonly used is another limitation to their clinical use (van der Berg et al., 2012).

Memory questionnaires that rely on observations from the individual or their family have been found to be unreliable due to reporting bias (Thompson, 2010). Responses given in self-report questionnaires are also affected by personality and depressive mood symptoms (Ronnlund, Vestergren, Mantyla, & Nilsson, 2011). However, using the Everyday Memory Questionnaire, a subjective rating scale for everyday memory failures, patient and family reports were found to be highly correlated although individual's ratings were more accurate when impairment is mild. Ratings by family members tended to have higher validity (Koltai et al., 1996).

3.7.6 The Rivermead Behavioural Memory Test (RBMT)

The Rivermead Behavioural Memory Test is used in the current study to explore the relationship between PM and dementia. It is a standardised measure of prospective memory that was developed in 1985 by Barbara Wilson, Janet Cockburn and Alan Baddeley to assess memory abilities through the performance of everyday tasks (Wilson, Cockburn & Braddley, 1989). While the test was originally used in the assessment of memory in adults with acquired neurological damage, its use has spread to other population groups including the elderly. Through the sampling of memory behaviours that are typical of everyday life the RMBT is seen an ecologically sound tool for the assessment of memory (Glass, 1999; Johansson & Wressle, 2012; Makatura et al., 1999). Long and short term memory is assessed for both verbal and visual information and as discussed previously PM is also assessed (Efklides et al., 2002). The test takes about 30 minutes to complete. New Zealand normative data for the RBMT has been developed and New Zealand elderly participants found the RBMT to be non-stressful and even enjoyable (Fraser, Glass, & Leathem, 1996). Reliability of the RBMT is described as high at 0.96 on a one week test-retest with inter-rater reliability of 1.0 (Fraser et al., 1996; Makatura et al., 1999).

There are conflicting views on the usefulness of the PM subtests within the RBMT. There has been criticism of the small number of PM tasks in the RBMT. This in turn limits chances to perform the PM task and consequently may not be a true reflection of a participant's prospective remembering (McDaniel & Einstein, 2007). With multiple factors influencing PM performance, the small number of PM tasks used to evaluate

prospective remembering may be inadequate (Thompson, 2010). Delprado et al., (2012) also criticised the RMBT suggesting it would have reduced sensitivity and reliability due to its limited scale. It appears that ceiling effects may have been an issue in a couple of studies where there were no participants with dementia who scored above zero on two of the PM subtests (appointment and belonging). The participants were acknowledged as having severe dementia (Kazui et al., 2005). The same study found a group with MCI to be impaired on the PM subtests but healthy older people also showed impairment although not to the same level. As PM performance is susceptible to aging this result is not surprising but it was seen to reduce the usefulness of the RBTM for discriminating between normal aging and pathological aging of PM (Kazui et al., 2005). However Delprado et al., (2012) found an adaptation of the RBMT prospective memory subtests to be just as sensitive as the complex standardised measure CAMPROMPT in identifying MCI.

The RBMT has been found to have high predictive value and sensitivity in differentiating between MCI and dementia (Johansson & Wressle, 2012). The RBMT also differentiates individuals with possible dementia from healthy adults (Efklides et al., 2002) with large deficits found in a meta-analytic review of PM and dementia (van der Berg et al., 2012). The RMBT has also been criticised though for not being able to identify the underlying causational factors of impaired performance but was found to be accurate in discriminating moderate from severe memory impairment (Makatura et al., 1999).

The RBMT consists of 12 subtests: remembering a name; remembering a hidden belonging; remembering to request an appointment; picture recognition; remembering a

newspaper article (immediate recall and delayed recall); face recognition; remembering a

new route (immediate recall and delayed recall); delivering a message; orientation and

date. Three of the 12 subtests as shown in Table 6, combine to test PM: remembering to

request an appointment; remembering to deliver a message and remembering a hidden

belonging. All are event-based tasks requiring that an action occur in response to a cue.

This study investigates the predictive validity of these three PM subtests deconstructed.

Table 6

RBMT Prospective Memory subtests

1. Message - remembering to pick up and deliver a message during the two (immediate and delayed) route recall tests.

2. Appointment – remembering to ask a question regarding the appointment in response to a   cue.

3. Belonging – remembering to request the return of a hidden belonging in response to a prearranged cue.

A study by Huppert (1993) was the first to make a direct comparison between PM and

dementia. The RBMT message subtest was used which highlighted the sensitivity of the

combined three PM subtests to the early stages of dementia however the subtests were

not examined individually. Glass (1998) also examined the RBMT subtests, including the

PM subtests, comparing the performance of healthy older people, unwell older people

and older people with dementia. An extract from the results of the Glass study is shown

in 3.2. Once again PM was found to be sensitive to dementia. Glass (1998) then divided

the dementia group by diagnosis and found that two of the PM subtests; appointment

and message discriminated between VaD and non-vascular dementias but the other PM

subtest belonging was not discriminative. See Table 7. Both belonging and appointment

did not discriminate between brain injured people and healthy adults in a study by Wills,

Clare, Shiel, & Wilson (2000). Participants of both of Wills et al's, groups ranged in age

from 18-65 years with a mean age of 40.5 years making a comparison with the current

study less useful.

Tests of delayed recall have been shown to discriminate between VaD and DAT with DAT

showing greater impairment (Graham et al., 2004). As the RBMT subtests each have a

delayed component to them it is likely that both groups would show some impairment

but the DAT group would score lower on the delayed tests than the VaD group. Both

groups would likely do better on the first message test as there is minimal time lapse

between the instructions and carrying out the task than when they repeat the task later.

Each of the three subtests also offers a prompt if needed. The benefit of the prompt is

less clear. If there are issues with encoding then a prompt would be of no benefit if the

intention was not encoded. If the issues are with retrieval then a prompt is more likely to

be beneficial. The prompts are less likely to benefit those with dementia though as the

context for the task is unlikely to have been remembered (Glass, 1999). These

assumptions will be examined in this thesis.

It can be difficult at times to classify PM tasks as either focal or non-focal as

demonstrated by Kliegel et al., (2008) during a meta-analysis of PM tasks. This was the

case in classifying the RBMT PM tasks used in this study where classifying the 'belonging'

and 'appointment' cues were not clearly focal or non-focal. The belonging cue of "we

have finished this test" could be argued to act as a focal cue by prompting participants to gather belongings to leave at the end of their appointment. However with the tests being undertaken in the participant's homes participants are unlikely to be thinking about gathering their belongings therefore it could be argued that the cue is non-focal as it doesn't focus processing on the cue. The same situation occurred with the appointment cue. A buzzer going off often signals the end of an event therefore could be seen as focal but the sound of the buzzer could also be seen as non-focal as the ongoing activity doesn't really focus processing onto the cue. The final decision was made to classify the appointment cue and the belonging cue as non-focal.

As this study is specifically interested in the individual components of each of the subtests the three prospective memory tests will now be discussed separately.

Table 7

RBMT Subtest Raw Scores: Means, Standard Deviations and F Ratios

Subtests	Well (n=80)		Unwell (n=51)		Dementia (n=74)		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F (p<.001.)*
Appointment	1.58	0.67	2.66	1.45	0.84	0.74	22.34
Message	5.54	0.79	5.27	0.91	4.28	1.78	20.27
Belonging	3.42	0.95	3.41	0.72	2.79	1.18	09.26

(From Glass, 1999)

Message:

The message test is incorporated in the subtest route where participants follow a specific route around the room demonstrated first by the examiner. Participants are instructed to pick up an envelope prior to starting the route and to leave it at a predetermined spot. Towards the end of all testing the participant is asked to reproduce the route without further demonstration from the examiner. A prompt to pick up the envelope is given in both situations if needed. Message has been shown in studies to discriminate between DAT and VaD (Glass, 1998; Huppert & Beardsall, 1993). The cue is embedded in the ongoing activity so it acts as a focal cue which as noted earlier would generally make it easier to remember the prospective memory task. The focal cue is unlikely though to benefit those participants with DAT due to deficits in hippocampal regions implicated in the spontaneous retrieval of intentions. This may explain why this subtest has discriminated between the two dementias in the past. The prompt may be of benefit to both groups in the immediate test but the prompt is not expected to be of any benefit to the DAT group for the delayed test as the intention is unlikely to have been encoded effectively therefore making retrieval of the intention difficult.

There has been criticism as to whether 'message' is a true test of PM. The basis of this argument is that retrieval in the task is not self-initiated as participants are asked by the examiner to replicate a sequence of actions, including picking up and leaving an envelope. Maylor (1995) argues that the task tests retrospective memory not PM and that there is no difference between remembering to pick up the envelope and remembering to go to the window when retracing the route. While there may be some merit in this for the initial 'message' test, the delayed 'message' test does not include another demonstration

of the route and message pick up. Yes, the examiner still asks the participant to retrace the route taken earlier but no mention is made of the message. Therefore remembering to pick up and drop of the message in the delayed message test would appear to be a test of PM.

Appointment:

The appointment test begins with the examiner setting a timer to go off later in the session in front of the participant and asking the participant to remember a specific question regarding an appointment and to ask the question of the examiner when the timer's alarm sounded. If when the timer goes off the participant does not ask the question the examiner gives a prompt. Also noted is if the participant remembered that something had to be asked but could not remember what it was. This test assesses both the prospective component (remembering there was a question to ask) and the retrospective component (content of the question with or without prompt) of PM.

A similar scenario was used to assess PM in a study by Livner et al. (2009) where participants were asked at the beginning of the testing session to remind the examiner at the completion of all testing that an important phone call was to be made, testing both prospective and retrospective components. Participants with VaD or DAT were equally negatively affected on performance for both components in comparison to health older adults. Both groups though showed far greater deficits on the prospective component (remembering to remind the examiner) than on the retrospective component (remembering that it was a phone call to be made). The same scenario had been used earlier with participants with preclinical DAT with similar rates of impairment for both

components of prospective memory. Notable was only 11% of MCI participants, 8.9% of DAT group and 9.5% of VaD group succeeded on free recall (remembered to remind the tester without a prompt) compared to 33% and 32.1% of the two control groups. As this scenario is very similar to the RBMT appointment test used in this study it is expected that similar results will be found.

An alarm sounding is often a reminder to do something, for example: take food out of the microwave or open the door of the oven to check whatever is cooking. Therefore it could be expected to be a strong reminder for action. Cues that are distinctive in comparison to the ongoing task are associated with better PM performance (Einstein, McDaniel, Manzi, Cochran, & Baker, 2000). An alarm sounding during a testing session would certainly be distinctive. Unique to the RBMT appointment task is the score given to those participants who do not ask the question spontaneously or with a prompt but have awareness there was something to be asked but not what. The literature suggests that participants with VaD are more likely to ask the appointment question spontaneously than DAT whereas the prompt may trigger familiarity based memory with DAT participants who are more likely to make the comment that 'I know there is something I'm meant to ask but I can't remember what it was' as familiarity-based memory is less affected by hippocampus decay than recollection-based memory.

Belonging:

The belonging test involves the examiner placing an item belonging to the participant out of sight and asking the participant to remember to ask for the item back and remember its location when the examiner at the end of the RBMT states "we have finished this test".

A prompt is given if the belonging is not requested and if the location is not remembered. This test also assesses the prospective and retrospective components of PM. The PM cue "we have finished this test" has been categorised as non-focal in nature rather than focal and as such is not expected to benefit VaD more than DAT. In line with the other two subtests a prompt in this subtest is also unlikely to be of benefit to DAT.

This subtest has received support for its discriminative ability as an ecologically valid memory test of location recall (Bucks & Willison, 1997). While it was predicted that the value of a hidden belonging would influence the ease in which it was remembered this was not the case in the Bakker, Schretlen & Brandt (2010) study, as more valuable personal belongings did not reduce the amount of cues needed for participants to remember to ask for its return. The belonging subtest was not found to discriminate between DAT and VaD as a complete total in the Glass (1998) study but it is possible that by breaking the test into components that one or more of the components may benefit one group more than the other. Otherwise this study will give support to the findings of previous object location studies (Brandt et al., 2005; Bucks & Willison, 1997) that found object location tests are unable to differentiate between dementia types. These studies did find that those with dementia have greater difficulty in remembering the name of an item than where the item was situated and could differentiate healthy older people from those with dementia.

3.8   Summary

Prospective memory is responsible for the realisation of delayed intentions that commonly occur in everyday life. As such it is important for continued independence particularly for older people but is not routinely assessed. Prospective remembering occurs through automatic processes or strategic attentional resources depending on the focality of the PM cue. PM tasks involving focal cues tend to impact on the PM performance of people with DAT in the early stages of the disease to a greater degree than non-focal cues. Less clear is the impact of cue focality on PM performance of those with VaD. PM performance is also affected by the difficulty of the ongoing task. Prospective memory is not considered to be a standalone memory system as it relies on episodic, semantic and working memory to be able to perform well. Recognition memory is important for identifying PM cues and while retrospective memory differs from the retrospective component in PM it cannot be totally disregarded. PM declines with older age with larger decrements in MCI and dementia. PM tasks involving the use of focal cues have been found to discriminate between healthy older adults and adults with mild dementia. The RBMT can differentiate healthy older people from people with dementia but there is some debate over the contribution of the PM subtests. This study uses data that has already proven that the PM subtests can differentiate healthy older people from those with dementia so the question to be answered is not 'do they?' but 'how do they?'

Chapter Four

Method

4.1   Introduction

While there is evidence that PM is impaired in dementia and that two of the RBMT PM subtests discriminated between DAT and VaD in the Glass (1999) study, it is unclear which of the components of the subtests contributed the most to discriminating between the two dementias. The purpose of this study is to identify the actual components of these two subtests that contributed most towards discriminating between DAT and VaD. The results of which will contribute to the debate on the usefulness of the RBMT as a measure of PM.

Integral to PM is a delay between the forming of an intention and carrying out the intention. The literature indicates that the delay is most likely to be a prominent factor in differentiating between VaD and DAT. On tests involving delayed recall those with DAT were less likely to be able to recall information than those with VaD (Graham et al., 2004). This would suggest that those with DAT are more likely to demonstrate greater difficulty for the retrospective component of PM than VaD on all of the PM subtests in this study except however for the first component of message (immediate message), where there is minimal delay between the PM intention being formed and being carried out.

Realising delayed intentions in event-based PM requires recognition of the PM cue. PM cues are either focal and non-focal with recognition of non-focal cues more difficult (Henry et al., 2004; Kliegel et al., 2008). Non-focal cues don't align with the on-going task and processing resources tend to be focused on the on-going activity not the cue. Focal cues however tend to be embedded in the on-going activity and are therefore easier to recognise. The literature points towards tasks with non-focal cues being more difficult for older adults as a result of normal aging while DAT results in difficulties with both focal and non-focal cues. Just what effect VaD has on cue recognition is unclear.

Each of the RBMT PM subtests offers a prompt but these do not appear to have been examined previously to ascertain any contribution to prospective remembering in the RBMT test. The literature suggests that a prompt supports the retrospective component of PM to recall the content of the intention (Livner et al., 2009). As impairment in encoding appears to be a feature of DAT, participants with DAT are unlikely to benefit from a prompt if the content is not available to be recalled. A prompt is likely to cue recognition memory and as both the recollection and familiarity components of recognition memory are impaired by DAT (Hudon et al., 2009; Westerberg et al., 2006) the prompt may be of benefit to participants with VaD and as such discriminate between the two dementias.

The RBMT PM subtest belonging also includes a test of object location memory. Dementia has a negative impact on object location memory over and above the effects of normal aging. Performance differences have been reported between mild cognitive impairment and dementia but not between DAT and VaD (Bucks & Willison, 1997; Kessels

et al., 2010). Not reported on previously is whether the prospective component or the object location component of the RBMT belonging subtest shows greater impairment.

Significant gender differences have rarely been reported for PM, dementia or for the RBMT. While Glass (1999) reported a gender effect in the RBMT it was not for the PM subtests but for a test of delayed recall for a story. Glass (1999) noted that no report was made of gender differences in the initial standardisation of the RBMT and suggested that his finding reflected pathological changes in language processing as a result of dementia. Glass (1998) cited other studies that found females with dementia have greater difficulty with recalled prose than males with dementia. As previously noted the RBMT PM subtests include a component of delayed recall. Those components will be examined to ascertain if gender differences are present.

In summary, the hypotheses for this study are presented below.

4.2   Hypotheses

1. The second or delayed 'message' will discriminate between DAT and VaD rather than the immediate 'message'. The DAT group will score significantly lower on the subtest scores for the spontaneous component of the delayed message subtest than the VaD group.

2. In the appointment subtest the DAT group will show greater impairment on the spontaneous appointment component than on the appointment awareness

component. The DAT group will do worse than the VaD on the spontaneous component but better than the VaD group on the awareness component.

3. In the belonging subtest both dementia groups will achieve better results for remembering the location of the item than for remembering to ask for the belonging. Being prompted will not only provide a reminder to ask for the belonging but will also provide a strong cue for recollecting where the belonging is hidden.

4. Prompts given in each of the three PM subtests will be of more benefit to VaD than DAT.

5. Gender difference will have no effect on prospective remembering in three RBMT PM subtests.

4.3   Participants

The data for the dementia groups of Glass's 1999 study came from the case records of older people who had been referred to a regional psychogeriatric service for cognitive assessment during a 33 month period up until October 1994. The referrals came from inpatients, outpatient departments and a hospital day programme for improving living skills. The reasons given for referral to the memory clinic included requests for cognitive assessment and diagnosis, discharge planning and evaluation of suitability for cognitive remediation training (Glass, 1999). For nearly half of the referrals part of the assessment

was carried out in their own home. A total of 74 patients made up the sample. Selection criteria are described in the procedure.

4.4   Measure

As reported above, the measure used for this study is the PM subtests of the RBMT. An ecologically valid measure of everyday memory the RBMT is one of the few memory measures to also measure PM, the focus of this study.   New Zealand normative data has been developed for the RBMT making it a very appropriate measure for use with older adults in New Zealand (Fraser et al., 1996).

4.5   Procedure

A total of 165 case records (78 male and 87 female) were available from the original sample. At the time each record was reviewed to ensure criteria for selection was fulfilled. Criteria required that the participant met DSM-III-R (1987) third edition, revised, criteria for dementia; neuroimaging data was available as well as a RBMT profile. There were 91 people who met the criteria. Diagnosis was established by the review of neuroimaging reports by a consultant geriatrician as either probable vascular dementia or probable nonvascular dementia. There were 14 cases where a diagnosis could not be made from the medical data. In those cases a combination of behavioural reports from family or carers, neuropsychological test pattern and the history of cognitive symptom onset was used to classify each case (Glass, 1999).

The final number of cases in the study was reduced to 74 (41 female and 33 male) by the removal of thirteen cases due to complicating factors in the pathology and another four cases for early onset (under 60 years) dementia (Glass, 1999). This gave a vascular group of 35 participants and a non vascular group of 39 participants. The Mini Mental State Examination was used by Glass (1999) to ascertain degree of dementia severity and the majority of the cases were identified as being in the early to mildly demented stage.

The sample had a mean age of 74.79 years (range 60-89). Glass (1999) noted that there were no significant gender or age differences between the VaD and the DAT groups ($F[1,72] = .416$, $p>.05$ for gender and ($F[1,72] = .000$, $p>.05$ for age. The average number of years of education for participants was 10.19 years with 43% having completed less than 10 years formal education, 23% had completed 10 or 11 years and 32% had completed more than 11 years of formal education.

A low risk notification was submitted to the Research Ethics Office at Massey University prior to reviewing the data. Anonymity of the participants was assured by the use of numbered identification. On reviewing the raw data from the previous study for the current study, some anomalies became apparent. When data which had not been stored electronically was entered into an SPSS file, and basic statistics re-run, some discrepancies were revealed between the new output and the results reported by Glass (1999). These are shown in Table 8. It appeared that there was likely to be a slight difference between the participants used in the original study and those listed on the paper spreadsheet. As a result considerable time was spent reviewing the original patient files and psychometrics to account for each participant. The sample is however still made up of

the same number, gender mix and ages of VaD and DAT participants as the original study.

The characteristics of the participants after review are shown below in Table 9.

Table 8

Comparison of Glass (1999) Data and Data used in this Study

Subtest	VaD (n=35)				DAT (n=39)			
	Glass (1999)		Present		Glass (1999)		Present	
	M	SD	M	SD	M	SD	M	SD
Belonging	2.94	1.14	3.00	1.06	2.67	1.22	2.62	1.12
Appointment	1.03	0.75	1.20	0.80	0.67	0.70	0.77	0.67
Message	4.83	1.51	4.86	1.38	3.79	1.88	3.92	1.72

Table 9

Summary of Age Characteristics by Dementia Type Diagnosis

Diagnosis	n	Male	Female	Mean age	SD
Vascular	35	17	18	74.28	6.97
Nonvascular	39	16	23	75.26	6.80
Totals	74	33	41		

For this study the PM subtest raw scores were extracted from the total RBMT data pool

for closer inspection. For each of the three PM subtests the data was broken down

further to the individual components of each test for analysis. The individual components

are shown in Table 10. The three PM subtests were classified as event-based PM tests.

The PM subtest cues were also examined and classified. The message cue was classified

as focal as it was seen to align with the on-going activity. The on-going activity in the

appointment and belonging subtests did not focus processing onto the PM cues so the

two cues were classified as non-focal.

Table 10

RBMT Prospective Memory Subtests broken down into Test Components with

Corresponding Raw Scores

	Scoring		
Message	Immediate	Delayed	
Picked up spontaneously	2	2	
Picked up after prompt	1	1	
Left at correct location	1	1	Max score: 6

Appointment	Scoring	
Participant asked question spontaneously	2	
After a prompt	1	
Participant remembered that something had to be asked but could not remember what it was	1	Max score: 2

Belonging	Scoring	
Place recalled without prompt	2	
Place recalled with a prompt	1	
Request for item without prompt	2	
Request for item with a prompt	1	Max score: 4

Chapter Five

Results

The data analysis for this research focused on the effect of VaD and DAT on the individual

components of the RBMT PM subtests. The data was analysed using the Statistical

Package for the Social Sciences (SPSS; version 20) software programme. Comparisons of

mean scores for the RBMT PM subtests according to dementia group are shown in Table

5.1. Preliminary analysis found the data was not normally distributed therefore non-

parametric tests were used to analysis the data (Pallant, 2011). Firstly, the Mann-

Whitney U-Wilcox Rank Sum W Test was conducted to assess initial group differences on

the PM subtests. Table 11 shows that VaD scores are significantly different from DAT

scores on the subtests of appointment and message, as was expected with the close

similarity of data to the Glass (1999) study. Secondly, to address the hypotheses

presented in Chapter 4, Chi Square are used to analysis the components of each subtest.

Further analysis investigates the interaction between gender and PM using Chi Square.

Table 11

Prospective Memory Subtest Raw Scores

Subtest	VaD (n=35)		DAT (n=39)		Mann-Whitney U-Wilcox Rank Sum W Test	
	M	SD	M	SD	z	p
Appointment	1.20	0.80	0.77	0.67	-2.421	.015
Message	4.86	1.38	3.92	1.72	-2.386	.017
Belonging	3.00	1.06	2.62	1.12	-1.845	.065

Hypothesis 1

The second or delayed 'message' will discriminate between DAT and VaD rather than the immediate 'message'. The DAT group will score significantly lower on the subtest scores for the spontaneous component of the delayed message subtest than the VaD group.

Because the PM intention is carried out soon after its formulation in immediate message it had been hypothesised that the second or delayed 'message' would be a better discriminator of DAT and VaD. It was further hypothesised that the DAT group would score significantly lower on the subtest scores for the delayed component of the delayed message subtest than the VaD group.

As shown in Table 12, there was no significant between group differences for immediate message, z = -1.431, p = .143, but as hypothesised there was a significant difference between groups for delayed message z = -2.660, p = .008.

Table 12

The Immediate and Delayed Components of the Subtest Message

Message	VaD (n=35)		DAT (n=39)		Mann-Whitney U-Wilcox Rank Sum W Test	
	M	SD	M	SD	z	p
Immediate message	2.54	0.701	2.33	0.737	-1.431	.153
Delayed message	2.31	0.867	1.59	1.186	-2.660	.008

Further as hypothesised, a significant difference was found for delayed message with the

DAT group scoring lower than the VaD group but only when prompts were included

(94.3% VaD; 71.8%) X^2(1, N = 74) = 6.98, p = .030 as shown in Figure 2. No significant

difference was found when prompts were excluded (65.7% VaD; 43.6% DAT) X^2(1, N = 74)
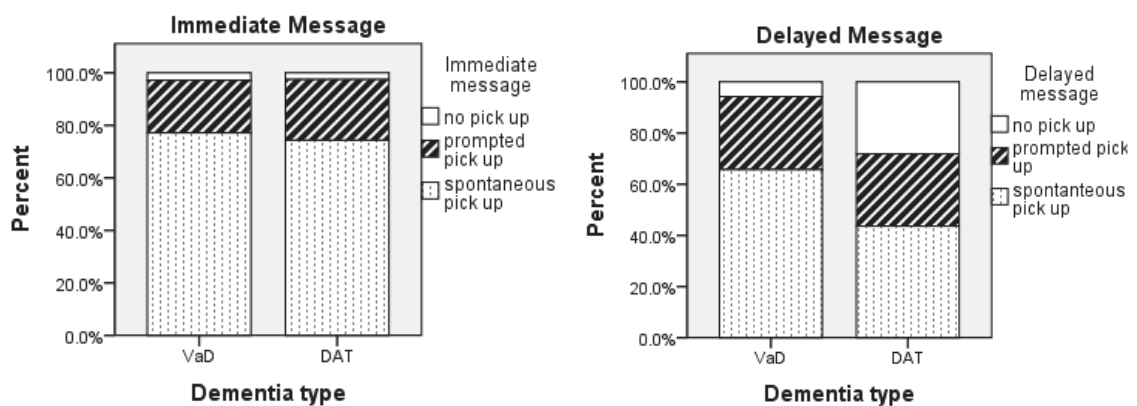
= 2.80, p = .094.

Figure 2

Remembering to pick up the Message: Immediate and Delayed.

There was a significant between group difference in the delayed condition as to whether

or not the message was left at the correct location with the DAT group scoring lower than

the VAD group (71.4% VAD; 43.6% DAT) X^2(1, N = 74) = 4.746, p = .029. This is illustrated
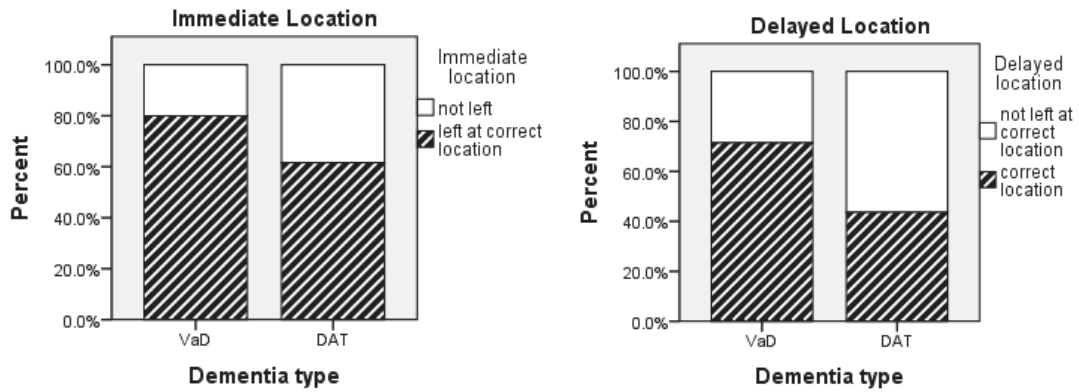
in Figure 2.

Figure 3

Remembering to Leave the Message in the Correct Place: Immediate and Delayed

Also as hypothesised immediate message was a poor discriminator with no between

group differences in terms of those who either picked up the message with or without a

prompt (97.1% VaD; 97.5% DAT) X^2(2, *N* = 74) = .106, *p* = .95; in Figure 1 or whether they

left it in the correct location (80% VaD; 61.5% DAT) X^2(1, *N* = 74) = 2.19, *p* = .14 in Figure

3.

Hypothesis 2

In the appointment subtest the DAT group will show greater impairment on the

spontaneous appointment component than on the appointment awareness component.

The DAT group will do worse than the VaD group on the spontaneous component but

better than the VaD group on the awareness component.

It had been hypothesised that the 'appointment' group difference noted in the Glass

(1999) study would be due to the spontaneous request component in the appointment

subtest with the DAT group showing greater deficits in spontaneously asking for an appointment than the VaD group. As shown in Figure 4 this was confirmed with the VaD group remembering to request an appointment more often than the DAT group (42.9% VaD; 12.8% DAT) X^2(1, N = 74) = 6.984, p = .008.

Also hypothesised was that having awareness that something needed to be asked but no memory of what it was, would describe the DAT group better than the VaD group. This was the case as shown in Figure 3 with the DAT group when aware that a request needed to be made, being less likely to remember the content of the request (41% DAT; 25.7% VaD) X^2(1, N = 74) = 1.933, p = .164. However in both groups there was no significant difference between the number of people within each group who had no awareness of needing to ask (47.1% VaD; 48.4% DAT) and those who had awareness but no memory of the request content (52.9% VaD; 51.6% DAT) X^2(1, N = 48) = .008, p = .930.
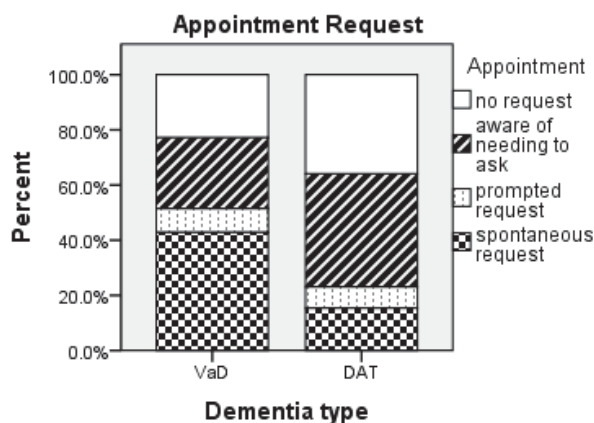

Figure 4

Appointment: Remembering to Ask for an Appointment

Hypothesis 3

In the belonging subtest both dementia groups will achieve better results for remembering the location of the item than for remembering to ask for the belonging. Being prompted will not only provide a reminder to ask for the belonging but will also provide a strong cue for recollecting where the belonging is hidden.

The third hypothesis that both groups would show greater memory impairment for remembering to request the return of their belonging compared to remembering where the item was hidden was also confirmed (37.1% & 82.9% VaD) X^2(4, N = 35) = 11.940, p = .018; (20.5% & 76.9% DAT) X^2 (4, N = 39) = 5.202, p = .267. This is illustrated in Figure 5.

There was minimal difference between groups for the location of the belonging (82.9% VaD; 76.9% DAT, refer to Figure 5). While the DAT group showed greater impairment in remembering to request the item of belonging without a prompt (see Figure 5) in comparison to the VaD group, the difference did not reach significance level (37.1% VaD; 20.5% DAT) X^2(2, N = 74) = 4.206, p = .122.
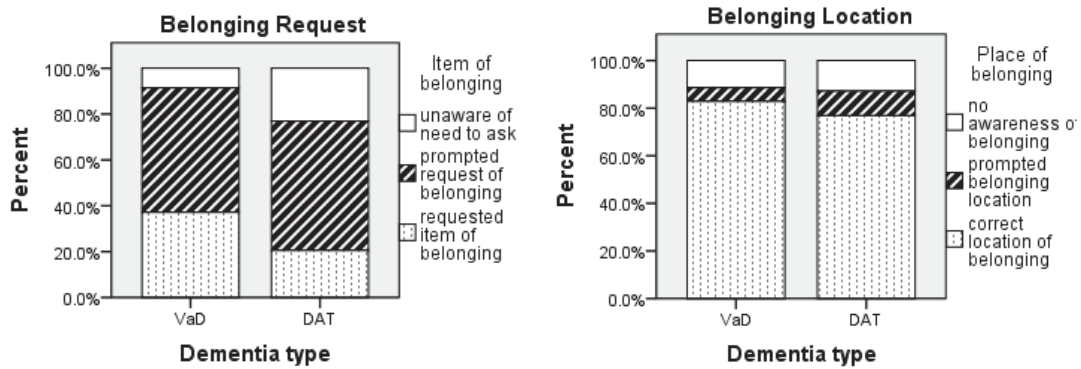
Figure 5

Belonging: Remembered to Ask for Belonging, Remembered the Location

Hypothesis 4

Prompts given in each of the three PM subtests will be of more benefit to VaD than DAT.

The hypothesis that prompts would be beneficial to the VaD group but not to the DAT group was not substantiated although reasonably few people required prompts (immediate message n=18; delayed message n=34; appointment n=52; belonging request n=53; belonging location n=15). In 'immediate message' a prompt was equally useful to both groups (of those who used a prompt 87.5% VaD; 90% DAT). In 'delayed message' a prompt was more valuable for the VaD group (83.3%) than the DAT group (50%). A prompt was similar benefit to both groups in 'appointment' (10.5% VaD; 9.1% DAT), 'belonging request' (86.4% VaD; 71% DAT) and 'belonging location' (33.3% VaD; 44.4% DAT). Overall prompts did not discriminate between dementia groups and were generally of similar benefit to each group.

Hypothesis 5

Gender will have no effect on prospective remembering in the three

RBMT PM subtests.

A gender analysis was conducted for all PM test components on the dementia group combined. No significant gender difference was found for spontaneously remembering to pick up the delayed message (63.6% males; 46.3% females) X^2(1, N = 74) = 2.202, p = .138 or for leaving it at the correct location (60.6% males; 53.7% females) X^2(1, N = 74) = .549. Neither was a significant gender difference found within VaD (64.7% male; 66.7% female) X^2(1, N = 35) = .015, p = .903 for picking up the delayed message or leaving it at the correct location (64.7% male; 77.8% female) X^2(1, N = 35) = .732, p = .392. Within the DAT group there was a significant gender difference for the spontaneous pick up of the message (62.5% male; 30.4% female) X^2(1, N = 39) = 3.946, p = .047 but not for leaving it in the correct location (56.2% male; 34.8% female) X^2(1, N = 39) = 1.768, p = .184 as shown in Figure 6.

Also, a notable within gender difference was noted for dementia type with females with DAT significantly less likely to spontaneously pick up the message than females with VaD (30.4% DAT; 66.7% VaD) X^2(1, N=41) = 5.331, p=.021 or leave the message at the correct location (34.38% DAT; 77.8% VaD) X^2(1, N=41) = 5.877, p=.015 in 'delayed message' whereas there was little difference between males as shown in Figure 6.
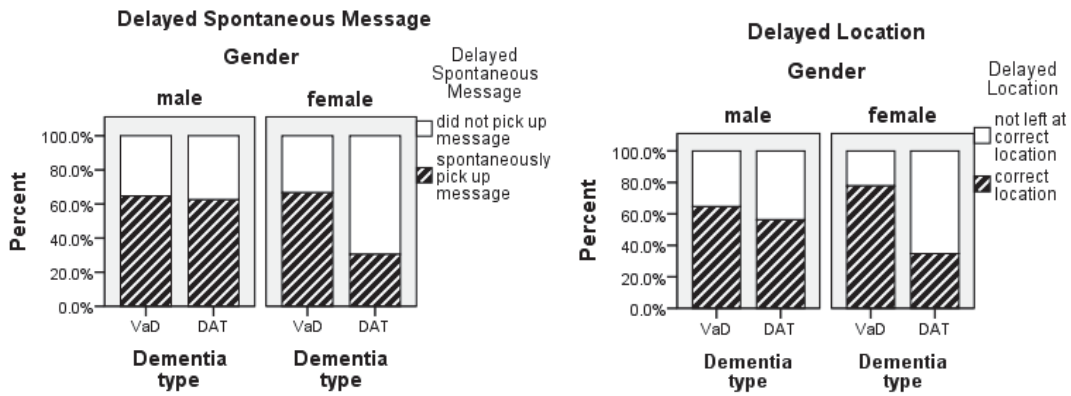
Figure 6

Gender: Delayed Spontaneous Pick-up and Location

When the appointment subtest was considered as a whole there were no gender differences evident. However, as displayed in Figure 7, examination of the individual components revealed a significant within gender group difference in the spontaneous request of an appointment for females with DAT again significantly less likely to remember to ask for an appointment than females with VaD (91.3% DAT; 55.6% VaD) $X^2(1, N = 41) = 5.193, p = .023$. There was no significant gender or within gender difference to any part of the belonging subtest.
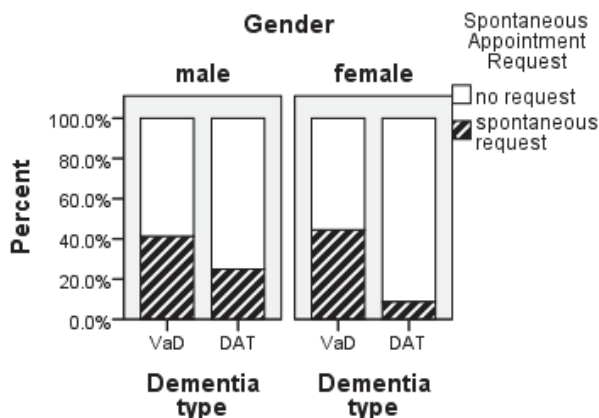

Figure 7

Gender: Remembering to Ask for an Appointment

The unexpected result that females with DAT experienced greater impairment on the

message and appointment PM tasks than other participants, led to a closer examination

of the participants ages to check for age bias within the groups. As previously noted

there were no gender age differences between VaD and DAT but it was unclear whether

there was a gender age difference within each group. The age groups by dementia and

gender are shown in table 13. If females with DAT were older than the participants in the

other groups then age may have been a factor given that DAT is likely to be more severe

with greater age. This turned out not to be the case, the female DAT group was the

youngest of the four groups. Accordingly, age did not explain the lower performance of

females with DAT in comparison to other participants.

Table 13

Dementia by Age and Gender

	VAD		DAT	
Age group	Male (n=17)	Female (n=18)	Male (n=16)	Female (n=23)
60-69	5	3	3	7
70-79	8	11	6	13
80-89	4	4	7	3
Mean age	73.53	74.72	78.06	73.04

5.1   Summary of results

The present study focused on deconstructing each of the three PM subtests in order to

answer the hypotheses. The initial focus was on the subtest 'message' which comprised

of two actions (remembering to pick up the message and remembering to leave the

message at the correct location) and three scoring components, the two just mentioned and use of a prompt, the third. The message test was given to each participant under two different conditions – immediate and delayed with each condition scored separately. Under the 'immediate' condition there was no effect for dementia type for either component of message. Under the 'delayed' condition the group with DAT showed greater impairment in remembering to pick up the message whereas the PM performance of the VaD group differed little between the immediate and the delayed conditions. DAT also experienced greater difficulty in remembering to leave the message at the correct location in comparison to the VaD group in both the immediate and the delayed condition. The difference between the two dementia groups for the delayed condition was significant. As a use of a prompt was a scoring component in all the subtests it will be discussed later separately.

The next PM subtest of focus was 'appointment'. Appointment consists of one action requiring participants to remember to request an appointment and three scoring components: spontaneous request; prompted request; awareness of needing to make a request. There was a significant effect for dementia type for remembering to make an appointment request spontaneously with the DAT group finding the task more than three times as difficult as the VaD group. Of those participants who did not remember to ask the examiner if they needed another appointment the DAT group had a greater awareness that something was expected of them but not what it was however this described many of the VaD group as well but to a slightly lesser extent. As previously mentioned the prompt scoring component will be discussed later in conjunction with the other two PM subtests.

The last PM subtest 'belonging' consists of two actions. The first, requesting the return of a belonging had two scoring components: spontaneous request for the return of the belonging and prompted request for the belongings return. The second, identifying the location of the belonging also has two scoring components: identified correct location of the belonging and prompted identification of belonging location. Both groups found it more difficult to remember to ask for the return of the belonging than to identify where the belonging was hidden. For the VaD group this difference was significant as once participants from this group were aware of the belonging request nearly all remembered the location of the belonging. The implications of this will be discussed later in this chapter.

As noted earlier a prompt is provided in each of the subtests if the participant does not make a request spontaneously. It had been predicted that a prompt would benefit the VaD group to a greater extent than the DAT group. The findings did not support this prediction. In fact overall a prompt was of marginally more benefit to the DAT group instead. Belonging was the only subtest that a prompt made a substantial difference to the performance of either group. A prompt was of significant benefit to both groups for remembering to ask for the belonging to be returned.

The effect of gender and dementia type on PM performance was examined for each of the scoring components of the subtests. PM performance was largely unaffected by gender except for the spontaneous components of delayed message and appointment. In delayed message females with DAT were significantly impaired compared with females

with VaD for both remembering to pick up the message and leaving it at the correct location. Females with VaD also performed at similar levels to males with VaD or DAT. The spontaneous component of appointment also demonstrated a similar effect with females with DAT being significantly more impaired on PM performance than females with VaD whereas the PM performance of males in each dementia group was undistinguishable.

Chapter Six

Discussion

6.1   Summary of aims and predictions

The aim of this present study was to extend the research of Glass (1998) into the interaction between PM and dementia. Glass (1999) found that two PM subtests (message and appointment) from the RBMT discriminated participants with VaD from participants with DAT. To understand the mechanisms behind those findings the present study utilises the original data from the Glass (1998) study to examine the predictive validity of the individual components of the RBMT PM subtests in discriminating between VaD and DAT. This study appears to be the first to examine the make-up of the RBMT PM subtests. Diagnosis of dementia requires information from different sources to act as markers for differential diagnosis, therefore with a greater understanding of the mechanism of PM tests, impairment in PM could become a marker for discriminating between VaD and DAT. Markers are important particularly for the differential diagnosis of VaD and DAT as often the presentation of each can appear similar. It was predicted that overall VaD would be associated with less impairment in PM than for DAT. It was expected that the delayed components of the PM subtests would be the most sensitive to impairment of PM in dementia with greater deficits in DAT in comparison to VaD. Also predicted was that being offered a prompt in any of the subtests would be of greater benefit to the VaD group than to the DAT group. Gender differences have not been

substantiated in PM and dementia. Therefore it was expected that PM performance would be unaffected by gender.

6.2   The prospective memory subtests

The RBMT has already been proven to be a sensitive measure of everyday memory and can separate dementia from healthy aging. The finding by Glass (1998) that two of the RBMT PM subtests (message and appointment) could also separate VaD from DAT raised the question of what mechanisms within each test were the most sensitive to each dementia. An examination of each of the PM subtests highlighted a number of observations.

The findings of the present study provide partial support for Maylor (1995) that the subtest message is not a true measure of PM as participants achieved near perfect scores on immediate message. PM is sensitive to the effects of aging therefore a near perfect score by nearly all of the older adult participants would be unlikely with a true measure of PM. This was borne out in delayed message with a noticeable drop in performance by all participants in remembering to pick up the message without a prompt. The VaD group showed similar overall performance between the two conditions with the prompt helping more of the VaD group to remember to pick up the message in the delayed condition than in immediate message. Performance in the DAT group dropped significantly between the two conditions with over a quarter of DAT participants not remembering to pick up the message. Leaving the message at the correct place resulted in similar findings and therefore doesn't appear to reflect the finding of Fraser (1996), who reported many

participants' score lower on the message subtest by returning the message to the examiner out of courtesy rather than leaving it at the specified place.

The message itself is a focal cue and focal cues being part of the on-going activity tend to be easier to remember than non-focal cues (Rose et al., 2010). Aging impacts negatively on the ability to identify both focal and non-focal cues (Uttl, 2011) and as expected PM performance was impaired in both dementia groups on most components of all three PM subtests. However, McDaniel et al., (2011) reported that focal cues are more difficult for people in the very early stage of DAT than non-focal cues. The present study does not support that view with the DAT group having had greater difficulty with the non-focal cues in the 'appointment' and 'belonging' subtests than with the focal cue in the 'message' subtest. This was also the case for VaD participants and is more consistent with the larger body of research evidence of non-focal cues being more difficult for older people to identify than focal cues (McDaniel & Einstein, 2000; Thompson, 2010). Another explanation for the higher level of performance by all participants on the spontaneous component of 'message' than on 'appointment' and 'belonging request' could be the wrongful categorisation of the 'message' cue and it actually being non-focal instead. A suggestion made earlier was that the prompt would not benefit DAT participants as the intention would not have been encoded effectively; this was not totally supported with 28.2% of DAT participants recalling the PM intention in 'delayed message' following a prompt.

All three subtests assessed both the prospective and the retrospective components of PM. A score for the spontaneous recall of the PM intention provided an assessment of

the prospective component and a score for recall following a prompt assessed the

retrospective component of PM. The latter checks whether the participant remembered

the content of the intention without the need for success of the prospective component

first. In the PM literature, dementia affects both the prospective and retrospective

components of PM (Thompson, Henry, Rendell, Withall, & Brodaty, 2010). Of all subtest

components, spontaneous recall, the prospective component, was found to be the most

sensitive to the effects of dementia on PM. The participants who spontaneously recalled

the PM intention in delayed message and delayed location were also more likely to

remember the content of the intention correctly. Being given a prompt if the intention

was not recalled spontaneously in delayed message, appointment and belonging was of

similar benefit to both dementia groups in each of the subtests. The retrospective

component was better preserved in VaD than in DAT.

Livner et al., (2009) reported that PM performance cannot distinguish between DAT and

VaD. As discussed previously Livner et al., (2009) utilised a PM test similar to

'appointment' with participants with VaD or DAT. The similarity allows for a comparison

of findings. In the Livner et al., (2009) study both dementia groups were found to be

equally impaired on both components of PM with only 8.9% DAT and 9.5% VaD

successfully remembering to remind the examiner and 26.6% DAT and 28.6% VaD

remembering the content of the intention; the findings of the present study do not

wholly concur. While both components of PM showed impairment in VaD and DAT, the

DAT group demonstrated greater impairment in the prospective component with 12.8%

DAT and 42.9% VaD successfully remembering to remind the examiner about an

appointment versus 20.5 % DAT and 48.6 % VaD remembering the content of the

intention. It appears that the prospective component of PM is more sensitive to DAT

than to VaD. Using the same PM task as in Livner (2009), Jones (2008) concluded that in

preclinical DAT the prospective and retrospective components of PM are similarly

impaired. It appears that the prospective component of PM is sensitive to the

progression from preclinical DAT to clinical DAT. The fact that participants in the present

study were not as impaired overall as those of the Livner et al., (2009) study is likely to be

reflective of the younger mean age of the participants in the present study and stage of

dementia. The participants of the present study were assessed as to be in the early to

mildly demented stage whereas the participants in the Livner et al., (2009) study were

reported to have mild to moderate dementia. These findings provide support for

Roman's (2003) observations that as VaD and DAT progress the symptoms of each

become more similar suggesting that the RBMT 'appointment' subtest may distinguish

between VaD and DAT in the mild stages of dementia but not once the dementia has

progressed to the moderate or severe stage.

The present findings support Livner et al. (2009) earlier finding as the retrospective

component is less affected by VaD than the prospective component of PM. However, in

the current study, in the appointment subtest, of those participants in the DAT group who

did not remember to ask if another appointment was required either spontaneously or

with a prompt, 41% were aware that there was something to be done but failed to

correctly remember what it was. Another 51.6% of DAT participants forgot the task

completely. This suggests that the retrospective component of PM is also significantly

impaired in DAT and to a greater degree than in VaD.

Recognition memory impacts on PM performance and researchers suggest familiarity based memory is preserved in DAT to a greater degree than recollection memory (Aggleton et al., 2005). Confirmation was provided with participants in the DAT group performing better on the awareness component of 'appointment' than on spontaneous or prompted recall. Also more participants in the DAT group reported they were aware they needed to do something but not what, than participants in the VaD group. These findings highlight that even when both the prospective and retrospective components of PM are impaired by DAT, familiarity based memory is still intact.

The belonging subtest was the one PM subtest identified by Glass (2008) that did not separate DAT from VaD. A closer examination of the scoring components that make up this test revealed that both groups had significant difficulty in remembering to ask for the belonging but the difference between the two groups was insignificant. The findings were similar for 'appointment' with the prospective component showing greater impairment than the retrospective component for the PM task. A high proportion of DAT participants correctly remembered to ask for the belonging when also provided with a prompt and nearly all VaD participants were able to make the request once prompted. Similar results were found for identifying the location of the belonging. Once participants had identified the item of belonging, most participants then spontaneously identified where the belonging had been hidden. This subtest had previously been identified as not only a test of PM but also a test of object location memory. These findings are consistent with previous research into the object location memory and dementia where object location tests did not discriminate between DAT and VaD (Bucks & Willison, 1997).

Therefore breaking down the 'belonging' subtest did not reveal any components that could discriminate between the two dementias.

A prompt in a PM test provides a test of the retrospective component of PM without the need for success first with the prospective component of the test. The prediction that a prompt would be of greater benefit to the VaD group than the DAT group had been based on a suggestion in the literature that encoding difficulties in DAT prevent the effective retention of information; therefore a prompt would not be helpful if the information was not there to retrieve. In the present study the rapid decay of information in participants with DAT, suggested by Desmond (2004), was demonstrated by less than a third of DAT participants whereas the majority of DAT participants recalled the content of the PM task. For those participants who used a prompt, a similar proportion in each group found the prompt helpful in retrieving the PM task supporting the viewpoint of (Vanderploeg et al., 2001) that rapid forgetting in DAT occurs as the disease progresses further. In the early stages of the disease people with DAT, like the participants in this study, demonstrate similar information retention as people with VaD.

Research into gender differences in dementia has not supported cognitive differences between males and females. The research is limited but those studies that have focused on gender differences in memory and dementia have concentrated on verbal and visuospatial memory without notable gender effects found in either (Beinhoff et al., 2008; Xing et al., 2012). Using the Mini Mental State Examination with people with VaD and DAT did not detect gender differences in VaD and DAT either (Groves et al., 2000). Glass (1999) had reported gender differences using the RBMT but not for the combined PM

subtests and had highlighted the need for further investigation. The present study

provides further confirmation that gender does not affect prospective remembering in

dementia. It was therefore even more surprising to find a within gender difference

between DAT and VaD. Females with DAT were significantly more impaired in PM in the

'delayed message', 'delayed location' and 'appointment' subtests than females with VaD

or males with either dementia type. These findings were not explained by stage of

disease progression or DAT participants being older in age than the other groups.

Other factors may have influenced the findings of the present study. The nature of the

ongoing activity during prospective memory tasks, impacts on the ease of prospective

remembering (Rendell et al., 2007). When high effort is put into the ongoing activity in

event-based PM tasks, cue detection can suffer (Marsh, Hicks, & Cook, 2005). The

ongoing activities in this study involved other cognitive tests that required considerable

attention from the participant. As attentional resources decline with age and are affected

by dementia (Brewer et al., 2010), it is unlikely that participants were able to use

monitoring to identify the PM cues. Therefore the RBMT PM subtests would appear to be

giving a true assessment of PM performance contrary to the argument of Kvavilashvili &

Fisher (2007) that PM tests administered over a short period of time are likely to be an

assessment of monitoring ability. Another influencing factor maybe the order in which

the RBMT subtests are presented. Glass (1999) proposed that changing the position of

'belonging' in the order in which participants do the test may give a different result.

6.3   Limitations and recommendations

A strength of this study was the careful selection process used by Glass (1998) that

included a formal clinical diagnosis of dementia and neuroimaging data. A limitation of

this research is the age of the data used. Since 1998 there have been technological

advances that have improved the quality of scans. Scans were used as part of the

diagnostic process to categorise the participants in this study into the VaD group or the

DAT group. It is possible that, had higher quality scans been available, some participants

may have been categorised differently. The sample size of this study was 74 participants,

a size dictated by the study of Glass (1998) from which the data originated. Through the

process of separating out each of the subtest components the sample being analysed in

some of the components became quite small. Statistical power could have been

increased through the use of a larger sample and while this may have identified small

reliable differences it is unlikely that by doing so, it would have made a difference in

terms of the size of the effect needed to be able to say in a real-world sense that the

subtests were any more predictive of one dementia or the other (Beins, 2012). Another

limitation was the difficulty in classifying the PM cues and possibly a different process for

classifying the cues could have been used. It may have been useful to have included the

data of the healthy older adults from the Glass (1999) study for a comparative view with

each dementia group on the PM test components.

Future research is recommended into the area of gender and dementia to further confirm

a gender difference in the prospective memory performance people with DAT and to

clarify if dementia type does affect the PM performance of females differently. The

RBMT PM subtests have previously been unable to discriminate between DAT and severe MCI (Kazui, et al., 2005). The sensitivity of the RBMT PM subtests to early cognitive changes in dementia may see it better suited to discriminating between early MCI and dementia, this warrants further research.

In conclusion, PM is affected by aging and impaired to a greater extent by the early stages of dementia. The RBMT PM subtests have been reported in the research to be sensitive to the early stages of dementia, particularly the subtests 'message' and 'appointment'. The present study sort to identify the factors in those two subtests that meant they were predictive and to identify why 'belonging' a similar test of PM wasn't as predictive of dementia. The subtest component that revealed the most impairment in both dementia groups was the spontaneous recall of a PM intention. This component assessed the prospective rather than the retrospective part of PM, finding that participants had greater difficulty remembering to carry out the intention at the appropriate time than remembering what had to be done. The exception was the DAT group in 'appointment' where more participants were aware of needing to do something but could not remember what.

The component that was the least sensitive to dementia was 'immediate message' with most participants achieving a full score. A further aim of the study was to identify if any of the components of 'message' and 'appointment' could discriminate between DAT and VaD. Two components of 'message': delayed message and delayed location discriminated between DAT and VaD. In the 'appointment' subtest the spontaneous request component also discriminated between the two dementias. While a significant

difference was found in both subtests the difference was not large enough for either subtest for it to be used to confidently predict one dementia or the other. There was no gender difference between males with DAT or VaD and females with VaD. Females with DAT though experienced significantly greater PM impairment than females with VaD. This study provides further confirmation that memory for future intentions is sensitive to the early stages of DAT and VaD and suggests that the RBMT PM subtest components 'delayed message' and 'appointment', may be useful as an additional marker to differentiate between these.

References

Aberle, I., Rendell, P. G., Rose, N. S., McDaniel, M. A., & Kliegel, M. (2010). The age-prospective memory paradox: Young adults may not give their best outside of the lab. *Developmental Psychology, 46*(6), 1444.

Aggleton, J. P., & Brown, M. W. (2006). Interleaving brain systems for episodic and recognition memory. *TRENDS in Cognitive Sciences, 10*(10), 455-462.

Aggleton, J. P., Vann, S. D., Denby, C., Dix, S., Mayes, A. R., Roberts, N., et al. (2005). Sparing of the familiarity component of recognition memory in a patient with hippocampal pathology. *Neuropsychologia, 43*, 1810-1823.

Albert, M., DeKosky, S. T., Dickson, D., Dubois, B., Feldman, H. H., Fox, N. C., et al. (2011). The diagnosis of mild cognitive impairment due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia, 7*(3), 270-279.

Albinski, R., Kliegel, M., Sedek, G., & Kleszczewska-Albinska, A. (2012). Positive effects of subclinical depression in prospective memory performance and ongoing tasks in young and old adults. *Aging, Neuropsychology and Cognition, 19*(1-2), 35-57.

Algarabel, S., Escudero, J., Mazon, J., Pitarque, A., Fuentes, M., Peset, V., et al. (2009). Familiarity-based recognition in the young, healthy, mild cognitive impaired and Alzheimer's patients. *Neuropsychologia, 47*(10), 2056-2064.

Algarabel, S., Fuentes, M., Escudero, J., Pitarque, A., Peset, V., Mazon, J., et al. (2012). Recognition memory deficits in mild cognitive impairment. *Aging, Neuropsychology and Cognition, 19*(5), 609-619.

Ally, B. A., Gold, C. A., & Budson, A. E. (2009). An evaluation of recollection and familiarity in Alzheimer's disease and mild cognitive impairment using receiver operating characteristics. *Brain and Cognition, 69*(3), 504-513.

Aly, M., Yonelinas, A. P., Kishiyama, M. M., & Knight, R. T. (2011). Damage to the lateral prefrontal cortex impairs familiarity but not recollection. *Behavioural Brain Research, 225*, 297-304.

American Psychiatric Association. (2000). *Diagnositic & Statistical Manual of Mental Disorders.* (4th ed.). Washington DC,: Author.

American Psychiatric Association. (2013). DSM 5 Development. Retrieved 19 July, 2013

Anderson, K., Launer, L. J., Ott, A., Hoes, A. W., Breteler, M. M. B., & Hofman, A. (1995). Do nonsteroidal anti-inflammatory drugs decrease the risk for Alzheimer's disease? The Rotterdam Study. *Neurology, 45*, 1441-1445.

Anstey, K. J., & Low, L. F. (2004). Normal cognitive changes in aging. *Australian Family Physician, 33*(10).

Apostolova, L. G., Green, A. E., Babakchanian, S., Hwang, S., Chow, Y., Toga, A. W., et al. (2012). Hippocampal atrophy and ventricular enlargement in normal aging, mild cognitive impairment and Alzheimer's disease. *Alzheimers Dis Ass Disord, 26*(1), 17-27.

Backman, L., Ginovart, N., Dixon, R. A., Wahlin, T. B., Wahlin, A., Halldin, C., et al. (2000). Age-related cognitive deficits mediated by changes in the striatal dopamine system. *American Journal of Psychiatry, 157*, 635-637.

Baddeley, A. (2001). Is working memory still working? *American Pyschologist, 56*, 851-864.

Baddeley, A., Eysenck, M. W., & Anderson, M. C. (2009). *Memory*. New York: Psychology Press.

Baddeley, A., Vargha-Khadem, F., & Mishkin, M. (2001). Preserved recognition in a case of developmental amnesia: Implications for the acquisition of semantic memory. *Journal of Cognitive Neuroscience, 13*(3), 357-369.

Bailey, P. E., Henry, J. D., Rendell, P. G., Phillips, L. H., & Kliegel, M. (2010). Dismantling the "age-prospective memory paradox": The classic laboratory paradigm simulated in a naturalistic setting. *The Quarterly Journal of Experimental Psychology, 63*(4), 646-652.

Bakker, A., Schretlen, D. J., & Brandt, J. (2010). Brief Report. Testing prospective memory: Does the value of a borrowed item help people remember to get it back? *The Clinical Neuropsychologist, 16*(1), 64-66.

Barker, W. W., Luis, C. A., Kashuba, A., Luis, M., Harwood, D. G., Loewenstein, D., et al. (2002). Relative frequencies of Alzheimer disease, lewy body, vascular and frontotemporal dementia and hippocampal sclerosis in the state of Florida brain bank. *Alzheimer Disease and Associated Disorders, 16*(4), 203-212.

Bashore, T., R., Ridderinkhof, K. R., & van der Molen, M. (1997). The decline of cognitive processing speed in old age. *Current Directions in Psychological Science, 6*(6), 163-169.

Bastin, C., Van der Linden, M., Charnallet, A., Denby, C., Montaldi, D., Roberts, N., et al. (2004). Dissociation between recall and recognition memory performance in an amnesic patient with hippocampal damage following carbon monoxide poisoning. *Neurocase, 10*(4), 330-344.

Beinhoff, U., Tumani, H., Brettschneider, J., Bittner, D., & Riepe, M. W. (2008). Gender-specifities in Alzheimer's disease and mild cognitive impairment. *J Neurol, 255*, 117-122.

Beins, B. C. (2012). *APA style simplified. Writing in psychology, education, nursing and sociology.* Chichester, UK: John Wiley & Sons, Inc.

Bennett, D. A., Wilson, R. S., Schneider, J. A., Evans, D. A., Beckett, L. A., Aggarwal, N. T., et al. (2002). Natural history of mild cognitive impairment in older persons. *Neurology, 59*, 198-205.

Benoit, R. G., Gilbert, S. J., Frith, C. D., & Burgess, P. W. (2012). Rostral prefrontal cortex and the focus of attention in prospective memory. *Cerebral Cortex, 22*(8), 1876-1886.

Berk, L. E. (2007). *Development through the lifespan.* Boston, MA: Pearson Education Inc.

Blanco-Campal, A., Coen, R. F., Lawlor, B. a., Walsh, J. B., & Burke, T. E. (2009). Detection of prospective memory deficits in mild cognitive impairment of suspected Alzheimer's

disease etiology using a novel event-based prospective memory task. *Journal of the International Neuropsychological Society, 15*, 154-159.

Bowles, B., Crupi, C., Mirsattari, S. M., Pigott, S. M., Parrent, A. G., Pruessner, J. C., et al. (2007). Impaired familiarity with preserved recollection after anterior temporal-lobe resection that spares the hippocampus. *Proceedings of the National Academy of Sciences of the United States of America, 104*(41), 16382-16387.

Brainerd, C. J., Reyna, V. F., Petersen, R. C., Smith, G. E., Kennedy, A. E., Gross, C. J., et al. (2013). The apolipoprotein E genotype predicts longitudinal transitions to mild cognitive impairment but not to Alzheimer's dementia: Findings from a nationally representative study. *Neuropsychology 27*(1), 86-94.

Brandt, J., Shpritz, B., Munro, C. A., Marsh, L., & Rosenblatt, A. (2005). Differential impairment of spatial location memory in Huntington's disease. *Journal of Neurol Neurosurg Psychiatry, 76*, 1516-1519.

Brewer, G. A., Knight, R. T., Marsh, R. L., & Unsworth, N. (2010). Individual differences in event-based prospective memory: evidence for multiple processes supporting cue detection. *Memory & Cognition, 38*(3), 304-311.

Brown, L. A., & Brockmole, J. R. (2012). Processing speed and visuospatial executive function predict visual working memory in older adults. *Experimental Aging Research, 38*, 1-19.

Brown, M. W., & Aggleton, J. P. (2001). Recognition memory: What are the roles of the perirhinal cortex and the hippocampus? *Nature Reviews Neuroscience, 2*, 51-61.

Bucks, R. S., & Willison, J. R. (1997). Development and validation of the Location Learning Test (LLT): A test of visuo-spatial learning designed for use with older adults and in dementia. *The Clinical Neuropsychologist, 11*(3), 273-286.

Burgess, P. W., Quayle, A., & Firth, C. D. (2001). Brain regions involved in prospective memory as determined by positron emission tomography. *Neuropsychologia, 39*(6), 545-555.

Busse, A., Bischkopf, H., Riedel-Heller, S. G., & Angermeyer, M. C. (2003). Mild cognitive impairment: prevalence and incidence according to different diagnostic criteria: Results of the Leipzig longitudinal study of the aged. (LEILA75+). *The British Journal of Psychiatry, 182*, 449-454.

Cansino, S., Trejo-Morales, P., & Hernandez-Ramos, E. (2010). Age-related changes in neural activity during source memory encoding in young, middle-aged and elderly adults. *Neuropsychologia, 48*, 2537-2549.

Carlson, M. C., Xue, Q., Zhou, J., & Fried, L. P. (2009). Executive decline and dysfunction precedes declines in memory: The women's health and aging study II. *Journal of Gerontology, 64A*(1), 110-117.

Carter, S. F., Caine, D., Burns, A., Herholz, K., & Lambon Ralph, M. A. (2011). Staging of the cognitive decline in Alzheimer's disease: insights from a detailed neuropsychological investigation of mild cognitive impairment and mild Alzheimer's disease. *International Journal of Geriatric Psychiatry, 27*, 423-432.

Cherry, K. E., Martin, R. C., Simmons-D'Gerolamo, S. S., Pinkston, J. B., Griffing, A., & Gouvier, W. D. (2001). Prospective remembering in younger and older adults: Role of the prospective cue. *Memory, 9*(3), 177-193.

Cheung, G., & Stapelberg, J. (2011). Quetiapine for the treatment of behavioural and psychological symptoms of dementia (BPSD): a meta-analysis of randomised placebo-controlled trials. *The New Zealand Medical Journal, 124*(1336), 39-50.

Chowdhury, R., Guitat-Masip, M., Bunzeck, N., Dolan, R. J., & Duzel, E. (2012). Dopamine modulates episodic memory persistence in old age. *Journal of Neuroscience, 32*(41), 14193-14204.

Cohen, A., West, R., & Craik, F. I. M. (2001). Modulation of the prospective and retrospective components of memory for intentions in younger and older adults. *Aging, Neuropsychology and Cognition, 8*(1), 1-13.

Convit, L., Tarshish, C., De Santi, S., Tsui, W., Rusinek, H., & George, A. (1997). Hippocampal volume reductions in individuals at risk of Alzheimer's Disease. *Neurobiology of Aging, 18*(2), 131-138.

Corder, E. H., Saunders, A. M., Strittmatter, W. J., Schmechel, D. E., Gaskell, P. C., Small, G. W., et al. (1993). Gene dose of apolipoprotein E type 4 allele and the risk of Alzheimer's disease in late onset families. *Science, 261*, 921-923.

Corrada, M. M., Kawas, C. H., Hallfrisch, J., Muller, D., & Brookmeyer, R. (2005). Reduced risk of Alzheimer's disease with high folate intake: The Baltimore longitudinal study of aging. *Alzheimers Dementia, 1*(1), 11-18.

Craik, F. I. M., Byrd, M. & Swanson, J. M. (1987). Patterns of memory loss in three elderly samples. *Psychology and Aging. 2*(1), 79-86.

Crowe, M., Andel, R., Pedersen, N. L., Johansson, B., & Gatz, M. (2003). Does participation in lesiure activities lead to reduced risk of Alzheimer's disease? A prospective study of swedish twins. *Journal of Gerontology, 58B*(5), 249-255.

Cummings, J. L. (2003). Use of cholinesterase inhibitors in clinical practice. *American Journal of Geriatric Psychiatry, 11*(2), 131-145.

d'Ydewalle, G., Luwel, K., & Brunfaut, E. (1999). The importance of on-going concurrent activites as a function of age in time- and event-based prospective memory. *European Journal of Cognitive Psychology, 11*(2), 219-237.

Davachi, L. (2006). Item, context and relational episodic encoding in humans. *Current Opinion in Neurobiology, 16*, 693-700.

de Jager, C. A., Oulhaj, A., Jacoby, R., Refsum, H., & Smith, A. D. (2012). Cognitive and clinical outcomes of homocysteine-lowering B-vitamin treatment in mild cognitive impairment: a randomized controlled trial. *International Journal of Geriatric Psychiatry, 27*, 592-600.

de la Torre, J. C. (2010). Vascular risk factor detection and control may prevent Alzheimer's disease. *Ageing Research Reviews, 9*, 218-225.

DeFina, L. F., Willis, B. L., Radford, N. B., Gao, A., Leonard, D., Haskell, W. L., et al. (2013). The
    association between midlife cardiorespiratory fitness levels and later-life dementia.
    Annals of Internal Medicine, 158(3), 162-168.

Deliotte Access Economics. (2011). *Updated Dementia Economic Impact Report, 2011, New
    Zealand*: Alzheimers New Zealand.

Delprado, J., Kinsella, G., Ong, B., Pike, K., Ames, D., Storey, E., et al. (2012). Clinical measures of
    prospective memory in amnestic mild cognitive impaiment. *Journal of the International
    Neuropyschological Society, 18*, 295-304.

Desmond, D. W. (2004). The neuropsychology of vascular cognitive impairment: Is there a specific
    cognitive deficit? *Journal of the Neurological Sciences, 226*, 3-7.

Desmond, D. W., Erkinjuntti, T., Sano, M., Cummings, J. L., Bowler, J. V., Pasquier, F., et al. (1999).
    The cognitive syndrome of vascular dementia: Implications for clinical trials.

Devine, M. E., Fonseca, J. A. S., & Walker, Z. (2013). Do cerebral white matter lesions influence the
    rate of progression from mild cognitive impairment to dementia? *International
    Psychogeriatrics, 25*(1), 120-127.

Diana, R. A., Yonelinas, A. P., & Ranganath, C. (2007). Imaging recollection and familiarity in the
    medial temporal lobe: a three-component model. *TRENDS in Cognitive Sciences, 11*(9).

Dubois, B., Feldman, H. H., Jacova, C., DeKosky, S. T., Barberger-Gateau, P., Cummings, J. L., et al.
    (2007). Research criteria for the diagnosis of Alzheimer's disease: revising the NINCDS-
    ADRDA criteria. *Lancet Neurology, 6*, 734-746.

Duchek, J. M., Balota, D. A., & Cortese, M. (2006). Prospective memory and apoliprotein E in
    healthy aging and early stage Alzhiemer's disease. *Neuropsychology, 20*(6), 633-644.

Dufouil, C., Alperovitch, A., & Tzourio, C. (2003). Influence of education on the relationship
    between white matter lesions and cognition. *Neurology, 60*, 831-836.

Efklides, A., Yiultsi, E., Kangellidou, T., Kounti, F., Dina, F., & Tsolak, M. (2002). Weshler Memory
    Scale, Rivermead Behavioural Memory Test and Everyday Memory Questionnaire in

Healthy Adults and Alzheimer Patients. *European Journal of Psychological Assessment, 18*(1), 63-77.

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of experimental Psychology: Learning, Memory and Cognition, 16*(4), 717-726.

Einstein, G. O., McDaniel, M. A., Manzi, M., Cochran, B., & Baker, M. (2000). Prospective memory and aging: Forgetting intentions over short delays. *Psychology and Aging, 15*(4), 671-683.

Einstein, G. O., McDaniel, M. A., Richardson, S., Guynn, M. J., & Cunfer, A. R. (1995). Aging and Prospective Memory: Examining the Influences of Self-Initiated Retrieval Processes. *Journal of Experimental Psychology: Learning, Memory and Cognition, 21*(4).

Erkinjuntti, T., Inzitari, D., Pantoni, L., Wallin, A., Scheltens, P., Rockwood, K., et al. (2000). Limitations of clinical criteria for the diagnosis of vascular dementia. *Annual New York Academy of Science, 903*, 262-272.

Feigin, V. L., Barker-Collo, S., Parag, V., Senior, H., Lawes, C. M. M., Ratnasabapathy, Y., et al. (2010). Auckland stroke outcomes study. *Neurology, 75*, 1597-1607.

Fisk, J. D., Merry, H. R., & Rockwood, K. (2003). Variations in case definition affect prevalence but not outcomes of mild cognitive impairment. *Neurology, 61*, 1179-1184.

Fletcher, P. C., Shallice, T., Frith, C. D., Frackowiak, R. S. J., & Dolan, R. J. (1998). The functional roles of prefrontal cortex in episodic memory II. Retrieval. *Brain, 121*, 1249-1256.

Forlenza, O. V., Diniz, B. S., Radanovic, M., Santos, F. S., Talib, L. L., & Gattaz, W. F. (2011). Disease-modifying properties of long-term lithium treatment for amnestic mild cognitive impairment: randomised controlled trial. *The British Journal of Psychiatry, 198*, 351-356.

Fraser, S. D., Glass, J. N., & Leathem, J. (1996). *Examination of Everyday Memory in an Elderly New Zealand Population: Improving the Utility of the Rivermead Behavioural Memory Test.* Masters of Science, Massey University, Palmerston North.

Freeman, J. E., & Ellis, J. A. (2010). The intention-superiority effect for naturally occurring activities: The role of intention accessibility in everyday prospective remembering in young and older adults. *International Journal of Psychology, 38*(4), 215-228.

Friedland, R. P., Fritsch, T., Smyth, K. A., Koss, E., Lerner, A. J., Chens, C. H., et al. (2001). Patients with Azheimer's disease have reduced activities in midlife compared with healthy control-group members. *PNAS, 98*(6), 3440-3445.

Frings, L., Wagner, K., Quiske, A., Schwarzwald, R., Spreer, J., Halsband, U., et al. (2006). Precuneus is involved in allocentric spatial location encoding and recognition. *Experimental Brain Research, 73*, 661-672.

Galton, C. J., Patterson, K., Xuereb, J. H., & Hodges, J. R. (2000). Atypical and typical presentations of Alzheimer's disease: a clinical, neuropsychological, neuroimaging and pathological study of 13 cases. *Brain 123*, 484-498.

Glass, J. N. (1998). Differential subtest scores on the Rivermead Behavioural Memory Test (RBMT) in an elderly population with a diagnosis of vascular or nonvascular dementia. *Applied Neuropsychology, 5*(2), 57-64.

Glass, J. N. (1999). *Measuring prospective memory in older adults: The relevance of everyday memory and the Rivermead Behavioural Memory Test.* Unpublished doctoral dissertation, Massey University, Wellington.

Gordon, B., Shelton, J. T., Bugg, J. M., McDaniel, M., & Head, D. (2011). Structural correlates of prospective memory. *Neuropsychologia, 49*, 3795-3800.

Graham, N., Emery, T., & Hodges, J. (2004). Distinctive cognitive profiles in Alzheimer's disease and subcortical vascular dementia. *Journal of Neurol Neurosurg Psychiatry 75*, 61-71.

Greve, A., Evans, C. J., Graham, K. S., & Wilking, E. L. (2011). Functional specialisation in the hippocampus and perirhinal cortex during the encoding of verbal associations. *Neuropsychologia, 49*, 2746-2754.

Greve, M., & O'Connor, D. (2005). A survey of Australian and New Zealand old age psychiatrists' preferred medications to treat behavioral and psychological symptoms of dementia (BPSD). *International Psychogeriatrics, 17*(2), 195-205.

Groves, W. C., Brandt, J., Steinberg, M., Warren, A., Rosenblatt, A., Baker, A., et al. (2000). Vascular dementia and Alzheimers disease: Is there a difference? A comparison of symptoms by disease duration. *Journal of Neuropsychiatry Clinical Neuroscience, 12*(3), 305-315.

Hampstead, B. M., Stringer, A. Y., Stilla, R. F., Amaraneni, A., & Sathian, K. (2011). Where did I put that? Patients with amnestic mild cognitive impairment demonstrate widespread reductions in activity during the encoding of ecologically relevant object-location associations. *Neuropsychologia, 49*, 2349-2361.

Hanninen, T., Hallikainen, M., Tuomainen, S., Vanhanen, M., & Soininen, H. (2002). Prevalence of mild cognitive impairment: a population-based study in elderly subjects. *Acta Neurologica Scaninavica, 106*, 148-154.

Hannulah, D. E., Libby, L. A., Yonelinas, A. P., & Ranganath, C. (2013). Medial temporal lobe contributions to cued retrieval of items and contexts. *Neuropsychologia*.

Harris, L. M., & Menzies, R. G. (1999). Mood and prospective memory. *Memory, 7*(1), 117-127.

Harrrison, T. L., & Einstein, G. O. (2010). Prospective memory: Are preparatory attentional processes necessary for a single focal cue? *Memory & Cognition, 38*(7), 860-867.

Hedden, T., & Gabrieli, J. D. E. (2004). Insights into the ageing mind: a view from cognitive neuroscience. *Neuroscience, 5*, 87-97.

Henry, J. D., MacLeod, M. S., Phillips, L. H., & Crawford, J. R. (2004). A meta-analyic review of prospective memory and aging. *Psychology and Aging, 19*(1), 27-39.

Hering, A., Cortez, S. A., Kliegel, M., & Altgassen, M. (2013). Revisiting the age-prospective memory-paradox: the role of planning and task experience. *European Journal of Ageing*.

Heyanka, D. J., Mackelprang, J. L., Golden, C. J., & Marke, C. D. (2010). Distinguishing Alzheimer's disease from vascular dementia: An exploration of five cognitive domains. *International Journal of Neuroscience, 120*, 409-414.

Holdstock, J. S., Mayes, A. R., Gong, Q. Y., Roberts, N., & Kapur, N. (2005). Item recognition is less impaired than recall and associative recognition in a patient with selective hippocampal damage. *Hippocampus, 15*, 203-215.

Howard, C., Bessette-Symons, B., Zhang, Y., & Hoyer, W. J. (2006). Aging selectively impairs recollection in recognition memory for pictures: evidence from modeling and receiver operating characteristic curves. *Psychology and Aging, 21*(1), 96-106.

Howard, L. R., Kumaran, D., Olafsdottir, H. F., & Spiers, H. J. (2011). Double dissociation between hippocampal and parahippocampal responses to object-background context and scene novelty. *The Journal of Neuroscience, 31*(14), 5253-5261.

Hudon, C., Belleville, S., & Gauthier, S. (2009). The assessment of recognition memory using the remember/know procedure in anmestic mild cognitive impairment and probable Alzheimer's disease. *Brain and Cognition, 70*(1), 171-179.

Hunsaker, M. A., Chen, V., Tran, G. T., & Kesner, R. P. (2013). The medial and lateral entorhinal cortex both contribute to contextual and item recognition memory: A test of the binding of items and context model. *Hippocampus, 23*, 380-391.

Huppert, F. A., & Beardsall, L. (1993). Prospective impairment as an early indicator of dementia. *Journal of Clinical and Experimental Neuropsychology, 15*(5), 802-821.

Huppert, F. A., Johnson, T., & Nickson, J. (2000). High prevalence of prospective memory impairment in the elderly and in early-stage dementia: Findings from a population-based study. *Applied cognitive psychology, 14*(7), 63-81.

Ihle, A., Schnitzspahn, K. M., Rendell, P. G., Luong, C., & Kliegel, M. (2012). Age benefits in everyday prospective memory: The influence of personal task importance, use of reminders and everyday stress. *Aging, Neuropsychology and Cognition, 19*(1-2), 84-101.

Jacoby, L. L. (1991). A process-dissociation framework: separating automatic from intentional uses of memory. *Journal of Memory and Language, 30*, 513-541.

Jeong, J. M., & Cranney, J. (2009). Motivation, depression, and naturalistic time-based prospective remembering. *Memory, 17*(7), 732-741.

Johansson, M., & Wressle, E. (2012). Validation of the Neurobehavioral Cognitive Status Examination and the Rivermead Behavioural Memory Test in investigations of dementia. *Scandinavian Journal of Occupational Therapy, 19*, 282-287.

Jones, S., Livner, A., & Backman, L. (2006). Patterns of Prospective and retrospective memory impairment in preclinical alzheimer's disease. *Neuropsychology, 20*(2), 144-152.

Kazui, H., Matsuda, A., Hirono, N., Mori, E., Miyoshi, N., Ogino, A., et al. (2005). Everyday memory impairment of patients with mild cognitive impairment. *Dementia Geriatric Cognitive Disorder, 19*, 331-337.

Kessels, R. P., Hobbel, D., & Postma, A. (2007). Aging, context memory and binding: A comparison of "what, where and when" in young and older adults. *International Journal of Neuroscience, 117*, 795-810.

Kessels, R. P., Rijken, S., Joosten-Weyn Banningh, L., van Schuylenborgh-Van, N., & Olde Rikkert, M. (2010). Categorical spatial memory in patients with mild cognitive impairment and Alzheimer dementia: Positional versus object-location recall. *Journal of the International Neuropsychological Society, 16*, 200-204.

Kim, J., Son, Y., Kim, H., Lee, S., Cho, S., Kim, Y., et al. (2011). Effects of age on dopamine D_2 receptor availability in striatal subdivisions: A high-resolution positron emission tomography study. *European Neuropsychopharmacolgy, 21*, 885-891.

Kirchhoff, B. A., Wagner, A. D., Maril, A., & Stern, C. E. (2000). Prefrontal-temporal circuitry for episodic encoding and subsequent memory. *The Journal of Neuroscience, 20*, 6173-6180.

Kliegel, M., Jager, T., & Phillips, L. H. (2008). Adult age differences in event-based prospective memory: A meta-analysis on the role of focal versus nonfocal cues. *Psychology and Aging, 23*(1), 203-208.

Knight, R. T., Meeks, J. T., Marsh, R. L., Cook, G. I., Brewer, G. A., & Hicks, J. L. (2011). An observation on the spontaneous noticing of prospective memory event-based cues. *Journal of Experimental Psychology: Learning, Memory and Cognition, 37*(2), 298-307.

Koltai, D. C., Bowler, R. M., & Shore, M. D. (1996). The Rivermead Behavioural Memory Test and Weschler Memory Scale-Revised: Relationship to Everyday Memory Impairment. *Assessment, 3*(4), 443-448.

Korczyn, A. D., Vakhapova, V., & Grinberg, L. T. (2012). Vascular dementia. *Journal of Neurological Sciences, 322*, 2-10.

Krause, B. J., Schmidt, D., Mottaghy, F. M., Taylor, J., Halsband, U., Herzog, H., et al. (1999). Episodic retrieval activates the precuneus irrespective of the imagery content of word pair associates. *Brain, 122*, 255-263.

Kvavilashvili, L., & Fisher, L. (2007). Is time-based prospective remembering mediated by self-initiated rehearsals? Role of incidental cues, ongoing activity, age and motivation. *Journal of Experimental Psychology: Learning, Memory and Cognition, 136*(1), 112-132.

Larrieu, S., Letenneur, L., Orgogozo, J. M., Fabrigoule, C., Amieva, H., Carret, N. L., et al. (2002). Incidence and outcome of mild cognitive impairment in a population-based prospective cohort. *Neurology, 59*, 1594-1599.

Larson, E. B., Wang, L., Bowen, J. D., McCormick, W. C., Teri, L., Crane, P., et al. (2006). Exercise is associated with reduced risk for incident dementia among persons 65 years of age and older. *Annals of Internal Medicine, 144*, 73-81.

Laukka, E. J., Jones, S., Small, B. J., Fratiglioni, L., & Backman, L. (2004). Similar patterns of cognitive deficits in the preclinical phases of vascular dementia and Alzheimer's disease. *Journal of the International Neuropsychological Society, 10*, 382-391.

Laukka, E. J., MacDonald, S. W. S., Fratiglioni, L., & Backman, L. (2012). Preclincial cognitive trajectories differ for Alzheimer's disease and vascular dementia. *Journal of the International Neuropsychological Society, 18*, 191-199.

Lewis, D. H. (2002). *Dementia in New Zealand: improving quality in residential care.* Wellington: Ministry of Health.

Li, J., Wang, Y. J., Zang, M., Xu, Z. Q., Gao, C. Y., Fang, C. Q., et al. (2011). Vascular risk factors promote conversion from mild cognitive impairment to Alzheimer's disease. *Neurology, 76*, 1485-1491.

Lindsay, J., Laurin, D., Verreault, R., Hebert, R., Helliwell, B., Hill, G. B., et al. (2002). Risk factors for Alzheimer's disease: A prospective analysis from the Canadian study of health and aging. *American Journal of Epidemiology, 156*(5), 445-453.

Livner, A., Berger, A., Karlsson, S., & Backman, L. (2008). Differential effects of depressive symptoms on prospective and retrospective memory in old age. *Journal of Clinical and Experimental Neuropsychology, 30*(3), 272-279.

Livner, A., Laukka, E. J., Karlsson, S., & Backman, L. (2009). Prospective and retrospective memory in Alzheimer's disease and vascular dementia: Similar patterns of impairment. *Journal of the Neurological Sciences, 283*, 235-239.

Looi, J. C. L., & Sachdev, P. S. (1999). Differentiation of vascular dementia from AD on neuropsychological tests. *American Academy of Neurology, 53*(4), 670-678.

Lopez, O. L., Becker, J. T., Wisniewski, S., Saxton, J., Kaufer, D. I., & DeKosky, S. T. (2002). Cholinesterase inhibitor treatment alters the natural history of Alzheimer's disease. *Journal of Neurol Neurosurg Psychiatry, 72*, 310-314.

Lopez, O. L., Jagust, W. J., DeKosky, S. T., Becker, J. T., Fitzpatrick, A., Dulberg, C., et al. (2003). Prevalence and classification of mild cognitive impairment in the cardiovascular health study cognition study. *Arch Neurology, 60*(1385-1389).

Luck, T., Luppa, M., Briel, S., & Riedel-Heller, S. G. (2010). Incidence of mild cognitive impairment: A systematic review. *Dementia Geriatric Cognitive Disorder, 29*, 164-175.

Lyketsos, C. G., Lopez, O. L., Jones, B., Fitzpatrick, A., Breitner, J., & DeKosky, S. T. (2002). Prevalence of neuropsychiatric symptoms in dementia and mild cognitive impairment. Results from the cardiovascular health study. *American Medical Association, 288*(12), 1475-1483.

Makatura, T. J., Lam, C. S., Leahy, B. J., Castillo, M. T., & Kalpakjian, C. Z. (1999). Standardized memory tests and the appraisal of everyday memory. *Brain Injury, 13*(5), 355-367.

Mantyla, T., Misser, F. D., & Nilsson, L.-G. (2009). Age differences in multiple outcome measures of time-based prospective memory. *Aging, Neuropsychology and Cognition, 16*, 708-720.

Marsh, R. L., Hicks, J. L., & Cook, G. I. (2005). On the relationship between effort toward an ongoing task and cue detection in event-based prospective memory. *Journal of experimental Psychology: Learning, Memory and Cognition, 31*(1), 68-75.

Martin, R., & Paki, P. (2012). Towards inclusion: The beginnings of a bicultural model of dementia care in Aotearoa New Zealand. *Dementia 11*(4), 545-552.

Mathias, J. L., & Burke, J. (2009). Cognitive functioning in Alzheimer's and vascular dementia: A meta-analysis. *Neuropsychology, 23*(4), 411-423.

Mattson, M. P. (2011). Pathways towards and away from Alzheimer's disease. *Nature 430*, 631-639.

Maylor, E. A. (1995). Prospective memory in normal ageing and dementia. *Neurocase, 1*(3), 285-289.

McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied Cognitive Psychology, 14*, S127-S144.

McDaniel, M. A., & Einstein, G. O. (2007). *Prospective memory: An overview and synthesis of an emerging field.* California: Sage Publications Inc.

McDaniel, M. A., Guynn, M. J., Glisky, E. L., Rubin, S. R., & Routhieaux, B. C. (1999). Prospective Memory: A Neuropsychological Study. *Neuropsychology, 13*(1), 103-110.

McDaniel, M. A., Shelton, J. T., Breneiser, J. E., Moynan, S., & Balota, D. A. (2011). Focal and non-focal prospective memory performance in very mild dementia: A signature decline. *Neuropsychology 25*(3), 387-396.

McGuinness, B., Barrett, S. L., Craig, D., Lawson, J., & Passmore, A. P. (2010). Attention deficits in Alzheimer's disease and vascular dementia. *Journal of Neurol Neurosurg Psychiatry, 81*, 157-159.

McKhann, G. M., Knopman, D. S., Chertkow, H., Hyman, B. T., Jr., C. R. J., Kawas, C. H., et al. (2011). The diagnosis of dementia due to Alzheimer's disease: Recommendations from the National Institute of Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimers Dementia, 7*(3), 263-269.

Mebane-Sims, I. (2009). 2009 Alzheimer's disease for facts and figures. *Alzheimer's & Dementia, 5*, 234-270.

Meguro, K., Tanaka, N., Nakatsuka, M., Nakamura, N., & Satoh, M. (2012). Vascular lesions in mixed dementia, vascular dementia and Alzheimer's disease with cerebrovascular disease: The Kurihara project. *Journal of Neurological Sciences, 322*, 157-160.

Melding, P. (2005). New Zealand's psychiatry of old services. Revisting 'the view from the bottom of the cliff' - have we made any progress since 1998? . *The New Zealand Medical Journal, 118*(1214).

Meulenbroek, O., Kessels, R. P., de Rover, M., Petersson, K. M., Marcel, G. M., Rikkert, O., et al. (2010). Age-effects on associative object-location memory. *Brain Research, 1315*, 100-110.

Meyer, J. S., Huang, J., & Chowdhury, M. H. (2007). MRI confirms mild cognitive impairments prodomal for Alzheimer's, vascular and Parkinson-Lewy body dementias. *Journal of Neurological Sciences, 257*, 97-104.

Meyer, J. S., Xu, G., Thornby, J., Chowdhury, M. H., & Quach, M. (2002). Is mild cognitive impairment prodromal for Vascular dementia like Alzhiemer's disease. *Stroke, 33*, 1981-1985.

Ministry of Health. (2011). *Tatau Kura Tangata: Health of older Maori chart book 2011.* Wellington: Ministry of Health.

Mitchell, A. J., & Shiri-Feshki, M. (2009). Rate of progression of mild cognitive impairment to dementia - meta-analysis of 41 robust inception cohort studies. *Acta Neurologica Scaninavica, 119*, 252-265.

Mitchell, T., Woodward, M., & Hirose, Y. (2008). A survey of attitudes of clinicians towards the diagnosis and treatment of mild cognitive impairment in Australia and New Zealand. *International Psychogeriatrics, 20*(1), 77-85.

Momennejad, I., & Haynes, J. (2012). Anterior prefrontal cortex encodes the 'what' and 'when' of future intentions. *Neurolmage, 61*, 139-148.

Mortimer, A. M., Likeman, M., & Lewis, T. T. (2013). Neuroimaging in dementia: A practical guide. *13*(92-103).

Mottaghy, F. M., Shah, N. J., Krause, B. J., Schmidt, D., Halsband, U., Jancke, L., et al. (1999). Neuronal correlates of encoding and retrieval in episodic memory during a paire-word association learning task: a functional magnetic resonance imaging study. *Experimental Brain Research, 128*, 332-342.

Nagata, K., Saito, H., Ueno, T., Sato, M., Nakase, T., Maeda, T., et al. (2007). Clinical diagnosis of vascular dementia. *Journal of the Neurological Sciences, 257*, 44-48.

Niedzwienska, A., & Barzykowski, K. (2012). The age prospective memory paradox within the same sample in time-based and event-based tasks. *Aging, Neuropsychology and Cognition, 19*(1-2), 58-83.

O'Brien, J., Erkinjuntti, T., Reisberg, B., Roman, G., Sawada, T., Pantoni, L., et al. (2003). Vascular cognitive impairment. *The Lancet Neurology, 2*, 89-98.

Ofen, N., & Shing, Y. L. (2013). From perception to memory: Changes in memory systems accross the lifespan. *Neuroscience & Behavioral Reviews, In press.*

Okuda, J., Fujii, T., Ohtake, H., Tsukiura, T., Tanji, K., Suzuki, M., et al. (2003). Thinking of the future and past: The roles of the frontal pole and the medial temporal lobes. *NeuroImage, 19*(1369-1380).

Okuda, J., Fujii, T., Ohtake, H., Tsukiura, T., Yamadori, A., Frith, C. D., et al. (2007). Differential involvement of regions of rostral prefrontal cortex (Bodmann area 10) in time- and event-based prospective memory. *International Journal of Psychophysiology, 64*, 233-246.

Oosterman, J. M., Oosterveld, S., Olde Rikkert, M., Classsen, J. A., & Kessels, R. P. (2012). Medial temporal lobe atrophy relates to executive dysfunction in Alzheimer's disease. *International Psychogeriatrics, 24*, 1474-1482.

Pallant, J. F. (2011). *SPSS Survival Manual: A step by step guide to data analysis using SPSS.* (4 ed.). Crows Nest, NSW: Allen & Unwin.

Park, D. C., Hertzog, C., Kidder, D. P., Morrell, R. W., & Mayhorn, C. B. (1997). Effect of age on event-based and time-based prospective memory. *Psychology and Aging, 12*(2), 314-327.

Parkin, A. J., & Walter, B. M. (1992). Recollective experience, normal aging and frontal dysfunction. *Psychology and Aging, 7*(2), 290-298.

Penningroth, S. L., & Scott, W. D. (2013). Prospective memory tasks related to goals and concerns are rated as more important by both young and older adults. *European Journal of Ageing*.

Persson, J., Nyberg, L., Lind, J., Larsson, A., Nilsson, L., Ingvar, M., et al. (2006). Structure-function correlates of cognitive decline in aging. *Cerebral Cortex, 16*, 907-915.

Petersen, R. C. (2004). Mild cognitive impairment as a diagnostic entity. *Journal of Internal Medicine, 256*, 183-194.

Petersen, R. C., Roberts, R. O., Knopman, D. S., Boeve, B. F., Geda, Y. E., Ivnik, R. J., et al. (2009). Mild cognitive impairment. Ten years later. *Arch Neurology, 66*(12), 1447-1455.

Petersen, R. C., Roberts, R. O., Knopman, D. S., Geda, Y. E., Cha, R. H., Pankratz, V. S., et al. (2010). Prevalence of mild cognitive impairment is higher in men. The Mayo clinic study of aging. *Neurology, 75*, 889-897.

Petersen, R. C., Stevens, J. C., Ganguli, M., Tangalos, E. G., Cummings, J. L., & DeKosky, S. T. (2001). Practice parameter: Early detection of dementia: Mild cognitive impairment (an evidence-based review). *Neurology, 56*, 1133-1142.

Piekema, C., Kessels, R. P., Mars, R. B., Petersson, K. M., & Fernandez, G. (2006). The right hippocampus participates in short-term memory maintenance of object-location associations. *NeuroImage, 33*, 374-382.

Polino, P., Desgranges, B., Benali, K., & Eustache, F. (2002). Episodic and semantic remote autobiographical memory in ageing. *Memory, 10*(4), 239-257.

Postma, A., Kessels, R. P., & Asselen, v. (2008). How the brain remembers and forgets where things are: The neurocognition of object-location memory. *Neuroscience and Biobehavioral Reviews, 32*, 1339-1345.

Ramsoy, T. Z., Liptrot, M. G., Skimminge, A., Lund, T. E., Sidaros, K., Christensen, S., et al. (2009). Regional activation of the human medial temporal lobe during intentional encoding of objects and positions. *NeuroImage, 47*, 1863-1872.

Reed, B. R., Mungas, D. M., Kramer, J. H., Ellis, W., Vinters, H. V., Zarow, C., et al. (2007). Profiles of neuropsychological impairment in autopsy-defined Alzheimer's disease and cerebrovascular disease. *Brain, 130*, 731-739.

Reese, C. M., & Cherry, K. E. (2010). The effects of age, ability and memory monitoring on prospective memory task performance. *A Journal on Normal and Dysfunctional Development, 9*(2), 98-113.

Reisberg, B., Ferris, S. H., Anand, R., De Leon, M., Schneck, M. K., Buttinger, C., et al. (1984). Functional staging of dementia of the Alzheimer's type. *Annals of the New York Academy of Sciences, 435*, 481-483.

Remy, F., Mirrashed, F., Campbell, B., & Richter, W. (2005). Verbal episodic memory impairment in Alzheimer's disease: A combined structural and functional MRI study. *NeuroImage, 25*, 253-266.

Rendell, P. G., & Craik, F. I. M. (2000). Virtual week and actual week: Age-related differences in prospective memory. *Applied Cognitive Psychology, 14*, S43-S62.

Rendell, P. G., McDaniel, M. A., Forbes, R. D., & Einstein, G. O. (2007). Age-related effects in prospective memory are modulated by ongoing task complexity and relation to target cue. *Aging, Neuropsychology and Cognition, 14*, 236-256.

Resnick, S. M., Pham, D. L., Kraut, M. A., Zonderman, A. B., & Davatzikos, C. (2003). Longitudinal magnetic resonance imaging studies of older adults: A shrinking brain. *The Journal of Neuroscience, 23*, 3295-3301.

Reynolds, J. R., West, R., & Braver, T. (2009). Distinct neural circuits support transient and sustained processes in prospective memory and working memory. *Cerebral Cortex, 19*(5), 1208-1221.

Ritchie, K., Artero, S., & Touchon, J. (2001). Classification criteria for mild cognitive impairment: A population-based validation study. *Neurology, 56*, 37-42.

Roman, G. (2003). Vascular dementia: Distinguishing characteristics, treatment and prevention. *Journal of American Geriatrics Society, 51*(5), S296-S304.

Ronnlund, M., Vestergren, P., Mantyla, T., & Nilsson, L. (2011). Predictors of self-reported prospective and retrospective memory in a population-based sample of older adults. *The Journal of Genetic Psychology, 172*(3), 266-284.

Rose, N. S., Rendell, P. G., McDaniel, M. A., Aberle, I., & Kliegel, M. (2010). Age and individual differences in prospective memory during "Virtual Week": The roles of working memory, vigilance, task regularity and cue focality. *Psychological Aging, 25*(3), 595-605.

Rovio, S., Kareholt, I., Helkala, E.-L., Viitanen, M., Winbald, B., Tuomilehto, J., et al. (2005). Leisure-time physical activities at midlife and the risk of dementia and Alzheimer's disease. *The Lancet Neurology, 4*(11), 705-711.

Royall, D. R., Lauterbach, E. C., Cummings, J. L., Reeve, A., Rummans, T. A., Kaufer, D. I., et al. (2002). Executive control function: A review of its promise and challenges for clinical research. *Journal of Neuropsychiatry Clinical Neuroscience, 14*(4), 377-405.

Rude, S. S., Hertel, P. T., Jarrold, W., Covich, J., & Hedlund, S. (1999). Depression-related impairments in prospective memory. *Cognition and Emotion, 13*(3), 267-276.

Sachdev, P. S., Brodaty, H., Valenzuela, M. J., Lorentz, L., Looi, J. C. L., Wen, W., et al. (2004). The neuropsychological profile of vascular cognitive impairment in stroke and TIA patients. *Neurology, 62*, 912-919.

Salthouse, T. (2000). Aging and measures of processing speed. *Biological Psychology, 54*, 35-54.

Sauvage, M. M., Beer, Z., & Eichenham, H. (2010). Recognition memory: Adding a response deadline eliminates recollection but spares familiarity. *Learning and memory, 17*, 104-108.

Scarmeas, N., Levy, G., Tang, M. X., Manly, J., & Stern, Y. (2001). Influence of leisure activity on the incidence of Alzheimer's disease. *Neurology, 57*(12), 2236-2242.

Scheff, S. W., Price, D. A., Schmitt, F. A., DeKosky, S. T., & Mufson, E. J. (2007). Synaptic alterations in CA1 in mild Alzheimer's disease and mild cognitive impairment. *Neurology, 68*, 1501-1508.

Schinka, P. D., John A., Loewenstein, P. D., David A., Raj, A., Schoenberg, M. R., Banko, J. L., Potter, H., et al. (2010). Defining mild cognitive impairment: Impact of varying decision criteria on neuropsychological frequencies and correlates. *American Journal of Geriatric Psychiatry, 18*(8), 684-691.

Schneider, J. A., Arvanitakis, Z., Leurgans, S. E., & Bennett, D. A. (2010). The neuropathology of probable Alzheimer's disease and mild cognitive impairment. *Annals of Neurology, 66*(2), 200-208.

Schnitzspahn, K. M., Ihle, A., Henry, J. D., Rendell, P. G., & Kliegel, M. (2011). The age-prospective memory-paradox: an exploration of possible mechanisms. *International Psychogeriatrics, 23*(4), 583-592.

Sclan, S. G., & Reisberg, B. (1992). Functional assessment staging (FAST) in Alzheimer's disease: Reliability, validity and ordinality. *International Psychogeriatrics, 4*(1), 55-69.

Scullin, M. K., & Einstein, G. O. (2010). Control of cost in prospective memory: Evidence for spontaneous retrieval processes. *Journal of Experimental Psychology: Learning, Memory and Cognition, 36*(1), 190-203.

Seelye, A. M., Schmitter-Edgecombe, M., Cook, G. I., & Crandall, A. (2013). Naturalistic assessment of everyday activities and prompting technologies in mild cognitive impairment. *Journal of the International Neuropsychological Society, 19*, 442-452.

Seidenberg, M., Guidotti, L., Nielson, K. A., Woodard, J. L., Durgerian, S., Zhang, Q., et al. (2009). Semantic knowledge for famous names in mild cognitive impairment. *Journal of the International Neuropsychological Society, 15*, 9-18.

Serra, L., Bozzali, M., Cercignani, M., Perri, R., Fadda, L., Caltagirone, C., et al. (2010). Recollection and familiarity in amnesic mild cognitive impairment. *Neuropsychology, 24*(3), 316-326.

Skinner, E., I, & Fernandes, M. A. (2007). Neural correlates of recollection and familiarity: A review of neurominaging and patient data. *Neuropsychologia, 45*, 2163-2179.

Smith, A. D., Smith, S. M., De Jager, C. A., Whitbread, P., Johnston, C., Agacinski, G., et al. (2010). Homocysteine-lowering by B vitamins slows the rate of accelerated brain atrophy in mild cognitive impairment: A randomized controlled trail. *PLoS ONE, 5*(9), e12244.

Smith, R. E., & Bayen, U. J. (2006). The source of adult age differences in event-based prospective

    memory: A multinomial modeling approach. *Journal of Experimental Psychology:*

    Learning, Memory and Cognition, 32(3), 623-635.

Spencer, W. D., & Raz, N. (1995). Differential effects of aging on memory for content and context:

    A meta-analysis. *Psychology and Aging, 10*(4), 527-539.

Snyder, P. J., Nussbaum, P. D., & Robins, D. L. (2006). *Clinical Neuropsychology. A pocket*

    handbook for assessment. Washington, DC: American Psychological Association.

Statistics New Zealand. (2011). National population projections. Retrieved 29 May, 2013, from

    www.statistics.govt.nz

Stewart, W. F., Kawas, C., Corrada, M., & Metter, E. J. (1997). Risk of Alzheimer's disease and

    duration of NSAID use. *Neurology, 48*, 626-632.

Strayer, D. L., Wickens, C. D., & Braune, R. (1987). Adult age differences in the speed and capacity

    of information processing: 2. An elctrophysiological approach. *Psychology and Aging, 2*(2),

    99-110.

Takeda, M., Tanaka, N., & Kudo, T. (2011). Gender differences in psychogeriatric disorders.

    Geriatrics & Gerontology International, 11, 377-382.

Taki, Y., Kinomura, S., Sato, K., Goto, R., Wu, K., Kawashima, R., et al. (2011). Correlation between

    grey/white matter volume and cognition in elderly people. *Brain and Cognition, 75*, 170-

    176.

Tam, J. W., & Schmitter-Edgecombe, M. (2013). Event-based prospective memory and everyday

    forgetting in healthy older adults and individuals with mild cognitive impairment. *Journal*

    of Clinical and Experimental Neuropsychology, 35(3), 279-290.

Terry, R. D. (2000). Cell death or synaptic loss in Alzheimer's disease. *Journal of Neuropathology*

    and Experimental Neurology, 59(12), 1118-1119.

Terry, R. D., Masliah, E., Salmon, D. P., Butters, N., DeTeresa, R., Hill, R., et al. (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.

Thompson, C. (2010). *Prospective memory function in mild cognitive impairment and early

dementia.* Unpublished doctoral dissertation, University of New South Wales.

Thompson, C., Henry, J. D., Rendell, P. G., Withall, A., & Brodaty, H. (2010). Prospective memory

function in mild cognitive impairment and early dementia. *Journal of the International

Neuropsychological Society, 16*, 318-325.

Tobias, M., Yeh, L.-C., & Johnson, E. (2008). Burden of Alzheimer's disease: population-based

estimates and projections for New Zealand, 2006-2031. *Australian and New Zealand

Journal of Psychiatry, 42*, 828-836.

Troyer, A. K., & Murphy, D. J. (2007). Memory for intentions in amnestic mild cognitive

impairment: Time- and event-based prospective memory. *Journal of the International

Neuropsychological Society, 13*, 365-369.

Uttl, B. (2011). Transparent meta-analysis: Does aging spare prospective memory with focal vs.

non-focal cues? *PLoS ONE, 6*(2).

Uttl, B., Graf, P., Miller, J., & Tuokko, H. (2001). Pro- and retrospective memory in late adulthood.

Consciousness and Cognition, 10, 451-472.

van Asselen, M., Kessels, R. P., Frijns, C. J. M., Kappelle, L. J., Neggers, S. F. W., & Postma, A.

(2009). Object-location memory: A lesion-behavior mapping study in stroke patients.

Brain and Cognition, 71, 287-294.

van der Berg, E., Kant, N., & Postma, A. (2012). Remember to buy the milk on the way home! A

meta-analytic review of prospective memory in mild cognitive impairment and dementia.

Journal of the International Neuropsychological Society, 18(4), 706-716.

Vanderploeg, R. D., Yuspeh, R. L., & Schinka, J. A. (2001). Differential episodic and semantic memory performance in Alzheimer's disease and vascular dementias. *Journal of the International Neuropsychological Society, 7*.

Veld, B. A. I. T., Ruitenberg, A., Hofman, A., Launere, L. J., Duijn, C. M. v., Stijnen, T., et al. (2001). Nonsteroidal antiinflamatory drugs and the risk of Alzheimer's disease. *The New England Journal of Medicine, 345*(21), 1515-1521.

Visser, P. J., & Verhey, F. R. J. (2008). Mild cognitive impairment as predictor for Alzheimer's disease in clinical practice: effect of age and diagnostic criteria. *Psychological Medicine, 38*(1), 113-122.

Vogels, W. W. A., Dekker, M. R., Brouwer, W. H., & Jong, R. d. (2002). Age-related changes in event-related prospective memory performance: A comparison between four prospective memory tasks. *Brain and Cognition, 49*, 341-362.

Volkow, N. D., Logan, J., Fowler, J. S., Wang, G., Gur, R. C., Wong, C., et al. (2000). Association between age-related decline in brain dopamine activity and impairment in frontal and cingulate metabolism. *American Journal of Psychiatry, 157*, 75-80.

Weiten, W. (2004). *Psychology themes and variations.* (6th ed.). Belmont Wadsworth/Thompson Learning.

West, R., & Bowry, R. (2005). Effects of aging and working memory demands on prospective memory. *Psychophysiology, 42*, 698-712.

West, R., & Craik, F. I. M. (2001). Influences on the efficiency of prospective memory in younger and older adults. *Psychology and Aging, 16*(4), 682-696.

Westerberg, C. S., Paller, K. A., Weintraub, S., Mesulam, M. M., Holdstock, J. S., Hayes, A. R., et al. (2006). When memory does not fail: Familiarity-based recognition in mild cognitive impairment and Alzheimer's disease. *Neuropsychologia, 20*(2), 193-205.

Wetterling, T., Kanitz, R., & Borgis, K. (1996). Comparison of different diagnostic criteria for vascular dementia (ADDTC, DSM-IV, ICD-10, NINDS-AIREN). *Stroke, 27*, 30-36.

Will, C. M., Rendell, P. G., Ozgis, S., Pierson, J. M., Ong, B., & Henry, J. D. (2009). Cognitively impaired older adults exhibit comparable difficulties on naturalistic and laboratory prospective memory tasks. *Applied Cognitive Psychology, 23*, 804-812.

Wills, P., Clare, L., Shiel, A., & Wilson, B. A. (2000). Assessing subtle memory impairments in the everyday memory performance of brain injured people: exploring the potential of the extended Rivermead Behavioural Memory Test. *Brain Injury, 14*(8), 693-704.

Wilson, B. A., Cockburn, J., Baddeley, A. D., & Hiorns, R. (1989). The development and validation of a test battery for detecting and monitoring everyday memory problems. *Journal of Clinical and Experimental Neuropsychology, 11,* 855-870.

Winbald, B., Palmer, K., Kivipelto, M., Jelic, V., Fratiglioni, L., Wahlund, L. O., et al. (2004). Mild cognitive impairment - beyond controversies, towards a consensus: report of the International Working Group on mild cognitive impairment. *Journal of Internal Medicine, 256*, 240-246.

Wolf-Dieter, H., & Zimmermann-Meinzingen, S. (2012). PET imaging in the differential diagnosis of vascular dementia. *Journal of Neurological Sciences, 322*, 268-273.

Wolk, D. A., Mancuso, L., Kliot, D., Arnold, S., E., & Dickerson, B. (2013). Familiarity-based memory as an early cognitive marker of preclinical and prodromal AD. *Neuropsychologia, 51*, 1094-1102.

Wolk, D. A., Signoff, E. D., & DeKosky, S. T. (2008). Recollection and familiarity in amnestic mild cognitive impairment: A global decline in recognition memory. *Neuropsychologia, 46*, 1965-1978.

Woods, S. P., Weinborn, M., Velnoweth, A., Rooney, A., & Bucks, R. S. (2012). Memory for intentions is uniquely associated with instrumental activities of daily living in healthy older adults. *Journal of the International Neuropsychological Society, 18*, 134-138.

Xing, Y., Wei, C., Chu, C., Zhou, A., Li, F., Wu, L., et al. (2012). Stage specific gender differences in cognitive and neuropsychiatric manifestations of vascular dementia. *American Journal of Alzheimer's Disease & Other Dementias, 27*(6), 433-438.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46*, 441-517.

Yoon, C. W., Seo, S. W., Park, J., Kwak, K., Yoon, U., Suh, M. K., et al. (2013). Cerebellar atrophy in patients with subcortical-type vascular congitive impairment. *Cerebellum, 12*, 35-42.

Yoon, C. W., Shin, J. S., Kim, H. J., Cho, H., Noh, Y., Kim, G. H., et al. (2013). Cognitive deficits of pure subcortical vascular dementia vs Alzheimer's disease. *Neurology, 80*, 569-573.

Yuspeh, R. L., Vanderploeg, R. D., Crowell, T. A., & Mullan, M. (2002). Differences in executive functioning between Alzheimer's disease and subcortical ischemic vascular dementia. *Journal of Clinical and Experimental Neuropsychology, 24*(6), 745-754.

Zeintl, M., Kliegel, M., & Hofer, S. M. (2007). The role of processing resources in age-related prospective and retrospective memory within old age. *Psychology and Aging, 22*(4), 826-834.

Zhou, T., Broster, L. S., Jiang, Y., Bao, F., Wang, L., & Li, J. (2012). Deficits in retrospective and prospective components underlying prospective memory tasks in amnestic mild cognitive impairment. *Behavioral and Brain Function, 8*(39), 1-9.