

THE EFFECTS OF REPEATED CHECKING ON MEMORY AND
METAMEMORY IN OLDER PEOPLE AND INDIVIDUALS WITH MILD
COGNITIVE IMPAIRMENT (MCI)

MILES JOHN LATTIMER

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Abstract

Changes in memory and concerns regarding memory performance are common in older people, with many fearing developing dementia. Older people both with and without objective memory impairment may engage in compensatory strategies to reduce feelings of uncertainty, including checking or a reliance on memory aids. However, a number of studies have demonstrated that checking may paradoxically lead to reductions in metamemory (memory confidence, vividness and detail) as well as potential reductions in memory accuracy.

The present study aimed to build upon previous research by adapting a stove paradigm developed by Radomsky, Gilchrist & Dussault (2006) to investigate the effects of repeated 'relevant' and 'irrelevant' checking on memory accuracy and metamemory in 20 community dwelling older people without memory problems, as well as a smaller sample of 14 individuals with mild cognitive impairment (MCI).

The study employed 2 x 2 mixed factorial experimental designs for both samples. The independent variable was checking type (relevant checking and irrelevant checking). Participants were randomly assigned to either a 'relevant checking' or an 'irrelevant checking' condition. Participants in the 'relevant checking' condition completed 15 'checks' of a non-functional replica stove while those in the 'irrelevant checking' condition completed 15 'checks' of a dosette box, before completing a final checking trial of the stove. The dependent variables were measures of memory accuracy and metamemory (confidence, vividness and detail) assessed at two time points (pre-checking and post-checking).

Consistent with earlier findings, repeated relevant checking led to significant decline in memory confidence, vividness and detail compared to the irrelevant checking condition for the older adult sample. The MCI sample showed significant decline in memory confidence following repeated checking although declines in vividness and detail did not reach significance. No change was observed in memory accuracy in either sample. The clinical and theoretical implications of this finding are discussed.

TABLE OF CONTENTS

LIST OF TABLES.....	ix
LIST OF FIGURES.....	x
CHAPTER	
1.0 INTRODUCTION	1
1.1 Ageing in the UK	1
1.2 Memory changes associated with ageing	3
1.2.1 Dementia	3
1.2.2 Memory decline and subjective memory concerns in normal ageing	6
1.2.3 Mild Cognitive Impairment	9
1.2.3.1 Diagnostic criteria	9
1.2.3.2 Prevalence	11
1.2.3.3 Onset, Course, Prognosis	11
1.2.3.4 Co-morbidity	13
1.3 Individual consequences of memory concerns	13
1.3.1 Memory self efficacy and stereotype threat in normal ageing	13
1.3.2 Individual consequences of MCI diagnosis	15
1.4 Compensatory strategies	16
1.4.1 Use of compensatory strategies for subjective memory concerns	16
1.4.2 Use of compensatory strategies in MCI	17
1.5 Interim summary	18
1.6 Repeated checking and memory	19

1.6.1	Repeated checking	19
1.6.2	The role of memory in repeated checking	20
1.6.3	The role of metamemory in repeated checking	21
1.6.4	Rachman's (2002) Cognitive Theory of Compulsive Checking	21
1.7	Experimental studies investigating repeated checking	23
1.7.1	Methodological approaches to investigating checking behaviour	23
1.7.2	Empirical evidence in non-clinical samples	23
1.7.3	Empirical evidence in clinical samples	27
1.8	Rationale for present study	29
1.9	Research questions	31
2.0	METHODOLOGY	32
2.1	Design	32
2.2	Participants	32
2.2.1	Older adult sample	32
2.2.1.1	Inclusion and exclusion criteria	33
2.2.1.2	Sample size	33
2.2.1.3	Recruitment process	33
2.2.2	Mild Cognitive Impairment sample	34
2.2.2.1	Inclusion and exclusion criteria	34
2.2.2.2	Sample size	34
2.2.2.3	Recruitment process	35
2.3	Experimental task	35
2.3.1	Stove task	36

	2.3.2	Dosette box task	36
2.4		Measures	37
	2.4.1	Clinical Dementia Rating Scale	37
	2.4.2	Geriatric Anxiety Inventory short form	38
	2.4.3	5-item Geriatric Depression Scale	38
	2.4.4	6-Item Cognitive Impairment Test	38
	2.4.5	Prospective and Retrospective Memory Questionnaire	39
	2.4.6	Item adapted from the Fear of Developing Alzheimer's Disease Scale	39
	2.4.7	Additional questions	40
	2.4.8	Experimental task measures	40
		2.4.8.1 Memory accuracy	40
		2.4.8.2 Memory confidence	40
		2.4.8.3 Vividness and detail	40
		2.4.8.4 "Remembering" vs. "knowing"	41
2.5		Ethical considerations	41
	2.5.1	Consent	41
	2.5.2	Distress	42
	2.5.3	Data storage	42
2.6		Procedure	43
3.0		RESULTS	47
	3.1	Treatment of data	47
	3.2	Demographics	48
	3.3	Descriptive data	49

3.3.1 Geriatric Anxiety Inventory Short Form (GAI-SF)	49
3.3.2 5-item Geriatric Depression Scale (5-item GDS)	50
3.3.3 6-Item Cognitive Impairment Test (6-CIT)	51
3.3.4 Prospective and Retrospective Memory Questionnaire (PRMQ)	51
3.3.5 Measure of memory confidence	52
3.3.6 Measure of memory vividness	54
3.3.7 Measure of memory detail	56
3.4 Baseline differences between the experimental conditions	57
3.5 Research questions	58
3.5.1 Research question 1: Does repeated relevant checking lead to significantly reduced memory confidence, vividness and detail for recall in older people and people with MCI, when compared to an irrelevant checking condition?	59
3.5.2 Research question 2: Does repeated relevant checking lead to significant reductions in memory accuracy in older people and people with MCI, when compared to an irrelevant checking condition?	63
Research question 3: Does repeated relevant checking lead to significant reductions in	65

	memory accuracy in older people and people with MCI, when compared to an irrelevant checking condition?	
	3.5.4 Research question 4: Do older people and individuals with MCI with a greater apprehension about developing Alzheimer's disease report a higher incidence of prospective memory slips in everyday life?	67
4.0	DISCUSSION	69
	4.1 Evaluation of findings	69
	4.1.1 Research question 1	69
	4.1.2 Research question 2	71
	4.1.3 Research question 3	72
	4.1.4 Research question 4	74
	4.2 Strengths and limitations of the study	74
	4.2.1 Design	74
	4.2.2 Participants	75
	4.2.3 Randomisation and blinding	77
	4.2.4 Statistical power	78
	4.2.5 Measures	78
	4.2.6 Experimental task procedure	80
	4.3 Theoretical implications of the findings	83
	4.4 Clinical implications of the findings	85
	4.5 Future research	86
	REFERENCES.....	89

APPENDIXES..... 110

LIST OF TABLES

Table		
1.	<i>Demographics for the older adult and MCI samples</i>	48
2.	<i>Descriptive statistics for the GAI-SF</i>	50
3.	<i>Descriptive statistics for the 5-item GDS</i>	50
4.	<i>Descriptive statistics for the 6-CIT</i>	51
5.	<i>Descriptive statistics for the subscales and total score of the PRMQ</i>	51
6.	<i>Descriptive statistics for pre- and post-checking memory confidence scores</i>	54
7.	<i>Descriptive statistics for pre- and post-checking memory vividness scores</i>	55
8.	<i>Descriptive statistics for pre- and post-checking memory detail scores</i>	57
9.	<i>Descriptive data for memory confidence, vividness and detail in older adult sample</i>	59
10.	<i>Descriptive data for memory confidence, vividness and detail in MCI sample</i>	61
11.	<i>Descriptive data on memory accuracy (proportion of participants making no mistakes)</i>	65
12.	<i>Descriptive data on remembering vs. knowing</i>	66

LIST OF FIGURES

Figures

1.	Older adult sample metamemory scores across pre- and post-repeated checking	60
2.	MCI sample metamemory scores across pre- and post-repeated checking	62
3.	Older adult sample memory accuracy scores pre- and post-repeated checking	64
4.	MCI sample memory accuracy scores pre- and post-repeated checking	64
5.	Number of participants reporting “remember” vs. “know” responses in the older adult sample post-repeated checking	66
6.	Number of participants reporting “remember” vs. “know” responses in the MCI sample post-repeated checking	67

1.0 Introduction

1.1 Ageing in the UK

Consistent with global demographic projections, the UK has an increasingly aging population and there are currently 11.4 million people aged over 65 years in the UK (Office for National Statistics, 2013), a figure that is expected to rise to over 16 million in the next 15 years. Moreover, the number of people aged over 85 years currently stands at over 1.5 million and is expected to double within the next 20 years (Office for National Statistics, 2013; 2015a). Current estimates for life expectancy at birth in the UK are 83.0 years for women and 79.3 years for men (Office for National Statistics, 2015b). Of people aged over 65 years in the UK 3.5 million live alone, the majority of whom, 70 %, are women (Office for National Statistics, 2013).

There are numerous challenges that older people may experience as they age which can impact quality of life, including changes to health status resulting in functional limitations (Stuck et al., 1999), more limited opportunities for social engagement (Wenger, 1997), and changes to cognitive functioning (Muangpaisan, Assantachai, Intalapaporn, & Pisansalakij, 2008; Salthouse, 2003). In spite of these challenges, research suggests normal ageing is perceived as a generally positive experience, with people aged 65 to 79 reporting the highest average levels of personal well-being and life satisfaction among all age groups in a survey conducted in the UK by the Office of Nation Statistics (ONS, 2016).

There is emerging evidence suggesting that concerns around cognitive functioning may be relatively widespread amongst older people (Jonkers, Geerlings & Schmand, 2000; Mitchell, 2008) and have been shown to be linked to reduced memory self-efficacy (Ramakers et al., 2009) and quality of life (Mol et al., 2007).

Jonkers and colleagues (2000) in a review of the literature showed that depending on the sampling methods used, between 25-50% of community dwelling older adults aged over 65 reported everyday memory performance to have declined compared to earlier functioning. A meta-analysis showed that even in the absence of objective memory difficulties, around 17% of community older adults reported subjective memory complaints (Mitchell, 2008). It is important to note when interpreting these findings that these studies did not provide evidence of the type of errors people were making, their impact or the interpretation of this perceived memory decline. Beliefs about the causation of memory difficulties have been shown to predict attendance at memory clinics, with individuals who believe their difficulties are pathological (Hurt, Burns, Brown & Barrowclough, 2011), as well as those with a close relative diagnosed with a dementia, or those with greater knowledge of dementia (Hodgson & Cutler, 2004) being more likely to seek formal help. This would suggest that as awareness of dementia increases, individuals who previously may have viewed declines in everyday memory performance as part of the normal aging process may now be more likely to view these as the signs of a pathological process.

Research has begun to focus on the prevalence and the possible adaptive as well as maladaptive consequences of anticipatory anxiety of developing dementia (French et al., 2012; Kessler, Bowen, Baer, Froelich & Wahl, 2012). A UK government survey indicated that 39% of respondents over the age of 55 reported fearing developing dementia more than any other major life-threatening condition, including cancer, heart disease, stroke and diabetes (Department of Health, 2013). Cutler and Hodgson (2001) showed that anxieties about developing dementia are common with 47% of cognitively healthy 40-60 year olds without a parental history of dementia reporting either being 'very' or 'somewhat' concerned about developing

Alzheimer's disease, this rose to 92% for those with a living parent who had been diagnosed with dementia. Suhr & Kinkela (2007) reported in a sample of healthy adults aged 50 to 85 years that fear of dementia is particularly pronounced in individuals with personal experience of caring for someone with dementia, those who score higher on measures of depression, individuals who perceive their memory functioning to be poorer, and those with more negative aging stereotypes. These studies investigated anxiety of developing dementia utilising a single question and likert scale response, there may however be large variation in the frequency or preoccupation with worry, evaluation of likelihood or when they worry it would develop meaning they may overestimate the current perceived threat in these individuals. Limited research exists on the potential consequences of dementia worry, however it has been associated with poorer wellbeing (Hodgson & Cutler, 1997) as well as higher levels of anxiety and depressive symptoms (Kinzer & Suhr, 2015). It has been suggested that anxiety about developing dementia may share similarities with the cognitive model of health anxiety proposed by Warwick and Salkovskis (1990), potentially affecting how an individual perceives their cognitive functioning as well as their likelihood of interpreting memory lapses and episodes of forgetting as indicative of dementia (Kessler et al., 2012).

1.2 Memory Changes Associated with Ageing

1.2.1 Dementia

Dementia is an umbrella term used for a number of degenerative neurological conditions (Lobo et al., 2000), the most common of which are Alzheimer's disease which accounts for about 62% of all dementias, Vascular dementia which accounts for 17%, Lewy-body dementia which accounts for 4% and Fronto-temporal dementia which accounts for 2% of dementias (Alzheimer's Society, 2014). A further 10% of

dementias are mixed dementia where changes in the brain due to more than one type of dementia occur simultaneously (Alzheimer's Society, 2014). Dementia involves variable progressive loss of cognitive functioning leading to loss of independence for performing activities of daily living and behavioural changes (Chertkow, Feldman, Jacova, Massoud, 2013; World Health Organisation (WHO, 2012). Notable early symptoms include memory loss and difficulties with problem solving, concentration and language (Chertkow et al., 2013; WHO, 2012). The greatest risk factor for developing dementia is age with prevalence doubling every 5 to 7 years after the age of 65 (Hofman et al., 1991). Other known risk factors include cardiovascular disease, high alcohol intake, depression, head injury, lower levels of education and a family history of dementia (Solomon et al., 2014).

The prevalence of dementia among over 65s is 7.1%, while the total number of people living with dementia in the UK is estimated at 850,000 for 2015. It is predicted that this will rise and that by 2025 there will be 1 million people living with dementia in the UK (Alzheimer's Society, 2014). It is estimated that only 46% of people in the UK with dementia receive a formal diagnosis or have contact with specialist services (Department of Health, 2013). This has led to an initiative to increase awareness and early diagnosis of dementia in the UK as part of The National Dementia Strategy (Department of Health, 2009) and subsequently The Prime Minister's Dementia Challenge (Department of Health, 2012). The challenge focuses on improving research, creating dementia friendly communities and continuing improvements in health and care, with commitments to increase diagnosis rates through regular health checks. This political drive for earlier diagnosis has however come under criticism due to concerns regarding potential harms resulting

from over diagnosis and limited evidence supporting benefits of early diagnosis (Brunet et al., 2012; Fox et al., 2013; Le Couteur, Doust, Creasey & Brayne, 2013).

Diagnosis earlier in the development of a dementia has been suggested to have a number of benefits (Leifer 2003, Prince, Bryce & Ferri, 2011), including relief gained from a better understanding of symptoms, maximising decision-making autonomy as well as access to services and the use of available pharmacological, psychological and psychosocial interventions. An implicit assumption is that an early diagnosis can also be accurate however there is considerable diagnostic uncertainty (Beach, Monsell, Phillips & Kukull, 2012; Mitchell, Meader & Pentzek, 2011) with cognitive impairment far from synonymous with dementia, it is also associated with a range of conditions including stroke (Coco, Lopez & Corrao, 2016), mild cognitive impairment (MCI; Petersen, 2004; Petersen et al., 2011) as well as normal ageing processes (Salthouse, 2003; Vestergren & Nilsson, 2011). An unintended consequence of increased awareness and earlier diagnosis may be that more individuals present to services with either subjective memory problems or MCI, which are associated with depression and anxiety disorders as well as lower self confidence (Iliffe & Pealing, 2010; Regan & Varanelli, 2013). Finally the limited effectiveness of available pharmacological interventions (Fox et al., 2013) and potential side effects of cholinesterase inhibitors including increased risk of hip fractures and syncope (Gill et al., 2009) raises further questions of the benefits of diagnosing patients before the usual point of presentation. While there is some evidence for cholinesterase inhibitors in mild to moderate dementia, there is no clear evidence that they can prevent or delay progression of early dementia symptoms and have not been shown to be effective in individuals with MCI (Masoodi, 2013; O'Brien et al., 2011).

1.2.2 Memory Changes and Subjective Memory Complaints in Normal Ageing

Normal aging is associated with mild decline in neuropsychological test performance that has been shown to be independent of degenerative neurological conditions such as dementia (Balota, Dolan & Duchek, 2000; Kliegel & Jager, 2006; Salthouse 2009; 2012). Measurable age-related change has been well established in tests of processing speed and working memory (Salthouse 2009; 2012), episodic memory (Anderson & Craik, 2000; Balota, Dolan & Duchek, 2000) and uncued prospective memory (remembering to carry out an intention at some time in the future) (Kliegel & Jager, 2006). Cross-sectional studies have suggested age-related cognitive decline begins in early adulthood (Salthouse 2009) however longitudinal studies have often found maintained levels of performance with more significant declines not apparent until age 60 or later (Salthouse 2009; 2010). The differences in results found between cross sectional and longitudinal studies could be explained by potential cohort differences that may confound cross sectional studies and prior test experience that may confound longitudinal studies. A series of studies (Salthouse 2010; 2013) using a quasi-longitudinal method, where multiple samples of participants are tested in different years providing an estimate of change without prior test experience, have suggested that the impact of cohort effects may be overestimated. Intriguingly there may be differences depending on type of cognition with gradual declines in reasoning and processing abilities that may begin as early as 20 and stability followed by decline at around age 60 for measures of acquired knowledge (Salthouse 2013).

However, significant memory impairment such as that seen in degenerative neurological conditions such as dementia, is not an inevitable part of aging (Lobo et al., 2000). The majority of cognitively and physically healthy older adults are able to

maintain functioning and independence in their everyday activities (Chatterji, Byles, Cutler, Seeman, & Verdes, 2015) in spite of the mild age-related changes in memory and cognition evidenced by these neuropsychological test findings (Anderson & Craik, 2000; Salthouse 2009; 2010). However, many older adults do report subjective memory complaints even though objective cognitive assessment may show their memory to be within normal limits given their age and education level (Gallassi et al., 2008; Ramakers et al., 2009; Weaver Cardin, Collie & Masters, 2008). Comparing reports of difficulties with memory using a single item and episodes of forgetfulness using a structured questionnaire amongst community dwelling older adults with and without objective memory impairment, Weaver Cardin, Collie and Masters (2008) found no difference in level of complaints regarding their memory and cognition. Importantly they found no relationship between subjective and objective measures of memory performance irrespective of the domain assessed. A potential limitation of this study is that participants were initially recruited as part of a six year longitudinal study on healthy aging, meaning neither group represents individuals who actively sought help from services, which may provide a better indicator of subjective memory problems. However similar results were found by Gallassi and colleagues (2008) who investigated subjective reports of memory impairment of ninety-two patients without dementia presenting to services over a 9 month period and found that nearly half of these individuals had no objective memory problem on formal neuropsychological testing. In both of these studies cognitive complaints were found to be strongly associated with symptoms of depression, even though neither study included individuals with diagnosed depression. This may be of particular importance given that anxiety and depression are common amongst older people, with the prevalence of anxiety disorders

estimated at 3.2% to 14.2% (Wolitzky-Taylor, Castriotta, Lenze, Stanley & Craske, 2010), while the prevalence of major depression and sub-threshold depressive symptoms ranges from 4.6% to 9.3% and 4.5% to 37.3% respectively (Meeks, Vahia, Lavretsky, Kulkarni & Jeste, 2009). A number of large population-based studies of community dwelling older people without dementia (Balash, Mordechovich, Shabtai, Giladi, Gurevich, & Korczyn, 2013; Benito-León, Mitchell, Vega, & Bermejo-Pareja, 2010; Slavin et al. 2010) have since replicated these findings, with subjective ratings of memory performance and self-efficacy found to be more strongly related to measures of depression and anxiety than neuropsychological test performance. Although these findings suggest that memory complaints are a stronger indicator of mood difficulties than awareness of memory decline, they do not exclude the possibility that there may be subtle changes not picked up by tasks used in these studies to assess objective memory performance that for more anxious or depressed individuals may affect appraisals of cognitive performance and impact beliefs about memory.

Longitudinal studies have similarly shown that subjective memory complaints increase with age although these subjective complaints are still often poorly associated with objective memory performance (Beaudoin & Desrichard, 2011; Frerichs & Tuokko, 2006; Mascherak & Zimprich, 2011). It has been suggested that differences in task demands between real life and neuropsychological tests may explain the poor correlation between objective memory performance and subjective complaints (Craik & Anderson, 1999; Osher, Flegal & Lustig, 2013). The majority of neuropsychological tests are designed to assess the limits of ability and therefore do not allow for the use of external aids or strategies (Bouazzaoui et al., 2010; Craik & Anderson, 1999), which may have a substantial impact on the

occurrence and frequency of memory errors. A meta-analysis of studies investigating prospective memory (Henry, MacLeod, Phillips & Crawford, 2004) provides an illustrative example of this, the performance of younger adults was shown to be superior to older adults in prospective memory tasks carried out in laboratory settings, however perhaps unexpectedly older adults outperform younger adults in naturalistic settings. This appears to be because older adults were able to make use of external aids and strategies to offset their poorer prospective memory ability in the naturalistic setting which they were not able to do in the laboratory task. This may mean that despite normative age-related changes predicting memory failures and lower memory confidence, for some older adults the use of compensatory strategies may play an important role in limiting the occurrence and frequency of memory errors.

1.2.3 Mild Cognitive Impairment

1.2.3.1 Diagnostic criteria

Mild cognitive impairment (MCI) was first introduced into the clinical domain as a diagnostic entity by a group of investigators from the Mayo Clinic in the late 1990s (Petersen et al., 1999; Petersen 2004) however there remains controversy and lack of consensus over its use as a diagnostic category (Fox et al., 2013; Garrett & Valle, 2014; Morris, 2012; Petersen et al., 2014). MCI is characterised by mildly impaired performance on objective neuropsychological tests but relatively intact global cognition and daily functioning (Albert et al., 2011). MCI is thought to represent a transitional state of cognitive impairment that may be a precursor to Alzheimer's disease (AD) or other forms of dementia (Feldman & Jacova, 2005; Winbald et al., 2004). It can be diagnosed in individuals who experience difficulties with memory (*amnestic MCI*) or with cognitive function (*non-amnestic MCI*) both

subjectively and objectively in relation to age and education norms, but who do not meet the diagnostic criteria for dementia and whose difficulties do not significantly impact on daily living (Albert et al., 2011; Petersen, 2004; 2011).

There have been a number of revisions (Petersen, 2004; 2011) to the clinical criteria for a diagnosis of MCI with recognition that MCI is more heterogeneous than originally thought (Alladi, Arnold, Mitchell, Nestor & Hodges, 2006; Nordlund, Rolstad, Hellstrom, Skogren, Hansen & Wallin, 2005; Ward, Arrighi, Michels & Cedarbaum, 2012). Despite these attempts to further refine the criteria, the use of MCI as a diagnostic label for a potential prodromal stage of dementia remains contentious (Beard & Neary, 2013; Garrett & Valle, 2014). There is still debate as to how best to operationalise these criteria (Stephan et al., 2013), as well as its predictive validity given this heterogeneity and usefulness as a diagnostic label for patients (Beard & Neary, 2013; Mattson, Brax & Zetterberg, 2010). MCI can now be divided into either single-domain or multiple-domain, depending on the number of cognitive domains that are impaired and can be further subdivided into both amnesic and non-amnesic variants (Langa & Levine 2014; Petersen, 2011). A classification of amnesic MCI (aMCI) is made where memory loss is considered the predominant symptom, while non-amnesic MCI (nMCI) refers to presentations where impairment is in other aspects of cognitive function not directly related to memory that may instead affect attention, language or visuospatial skills (Petersen, 2011). The lack of uniformity or a standardised approach to clinical diagnosis is also problematic with there being no agreed tests or cut-offs to determine objective cognitive decline or what constitutes preserved ability and independence in functional activities (Stephan et al., 2013). In practice this has led to a reliance on cognitive screening measures or clinical judgement in assessing whether a person

meets the criteria for MCI (Moreira, Hughes, Kirkwood, May, Mckeith & Bond, 2008; Smith & Bondi, 2013). A strong critique of these changes (Morris, 2012) is that due to this lack of criteria for what represents “mild problems” in performing daily activities, there is no clear categorical distinction between MCI and early stage dementia. The lack of sensitivity of screening tests combined with high incidence of health or mood difficulties (Palmer et al., 2007; Van der Linde, Stephan, Matthews, Brayne, & Savva, 2010) in this population and the subjectivity of clinical judgment likely contribute to false positives or false negatives in diagnosis (Smith & Bondi, 2013). Consequently different clinicians may have a propensity to either over or under diagnose, potentially leading to high diagnostic error (Brunet et al., 2012).

1.2.3.2 Prevalence

Estimates of prevalence and incidence rates of MCI vary due to poor consensus of diagnostic criteria between clinicians as well as different sampling and assessment procedures (Ward, Arrighi, Michels & Cedarbaum, 2012). Despite this MCI is still common with the prevalence of MCI, depending on the criteria used, ranging from 3% to 19% of adults over 65 years old (Gauthier et al., 2006).

1.2.3.3 Onset, course and prognosis

Known risk factors for the development of MCI include older age (Manly et al., 2008), fewer years of education (Hall et al., 2006; Stern et al., 2006), hypertension (Etgen et al., 2010) and depression (Geda et al., 2006). In a longitudinal study of cognitively normal individuals, depression more than doubled the risk of developing MCI after controlling for age, education and gender (Geda et al., 2006).

The estimates of outcomes for individuals with MCI show wide variation and the predictive value of MCI in identifying who will progress to dementia remains largely unrefined. However there is general agreement that the conversion rate from

MCI to dementia is higher than that for cognitively unimpaired individuals over 65 (Feldman & Jacova, 2005). Petersen (2011) proposed that certain subtypes of MCI may be more predictive of specific dementia diagnoses. Individuals with aMCI have been shown to be more likely to progress to Alzheimer's disease, at a rate of around 10-15% per year, compared to older adults with unimpaired cognitive function, who convert at a rate of 1-2% per year (Petersen et al., 2001). Further research has demonstrated that individuals with aMCI have around a 44% likelihood of developing Alzheimer's disease within one to three years of diagnosis (Schmidtke & Hermeneit, 2008). Individuals with subtypes of nMCI have been suggested to be at higher risk of progress to other dementias including vascular dementia, dementia with Lewy bodies and frontotemporal dementia (Petersen 2011), however at present the research evidence to support this is limited and suggests a high degree of instability in classification over time (Summers & Saunders, 2012). Post mortem studies of individuals identified as having MCI demonstrated no link between MCI subtype and brain pathology, with some even showing no pathology (Stephan, Matthews, Hunter, Savva, & Bond, 2012).

Although MCI is widely viewed as a prodromal stage of dementia, it is important to note that not all individuals with MCI necessarily progress to dementia as would be expected, instead there are many who will remain stable or even recover (Anchisi et al., 2005). A meta-analysis of cohort studies indicated that although this population is at increased risk, with around 5-10% converting to dementia in the first year, most people with MCI do not progress to dementia, even after 10 years, with some individuals showing improvement in cognitive functioning (Mitchell & Shiri-Feshki, 2009). In one study, as many as 19.5% of individuals diagnosed with MCI had improved to a level of normal cognitive function within three years of diagnosis

while a further 61% continued to meet criteria for MCI (Wolf et al., 1998). Taken together these findings suggest that MCI diagnosis may be a risk factor for dementia however further cognitive decline is far from inevitable, which raises questions about how patients make sense of this uncertain label and the potential psychosocial consequences of diagnosis for the individual (Beard & Neary, 2013).

1.2.3.4 Comorbidity

Patients with MCI commonly experience co-morbid anxiety and depression symptoms with rates reported as high as 45% and 61% respectively (Palmer et al., 2007; Van der Linde, Stephan, Matthews, Brayne, & Savva, 2010). Symptoms of both depression and anxiety have been shown to increase as memory performance decreases (McDougall, Becker, & Arheart, 2006). A systematic review found that individuals with MCI were more likely to experience neuropsychiatric symptoms compared to cognitively healthy controls, with 35-75% of individuals with MCI experiencing symptoms of depression, apathy, anxiety, irritability or sleep disturbance (Apostolova & Cummings, 2007). Individuals with MCI have also been shown to rate their quality of life lower than cognitively healthy controls (Muangpaisan et al., 2008).

1.3 Individual Consequences of Memory Concerns

1.3.1 Memory Self Efficacy and Stereotype Threat in Normal Ageing

A number of studies have demonstrated that even in the absence of objective memory difficulties, older people have more negative beliefs about their memory ability than younger adults (Lineweaver & Hertzog, 1998; Ryan & See, 1993). A longitudinal study found that over a six year period these negative beliefs about memory ability in older people worsened over time (McDonald-Miszczak, Hertzog & Hultsch, 1995). It has also been established that older adults consistently report

lower levels of memory self-efficacy or confidence in their memory ability than younger individuals and that this lack of confidence appears to be independent of actual memory changes (Wells & Esopenko, 2008). These beliefs also appear to be more vulnerable to influence from perceived poor performance and are more likely to associate memory failure with aging rather than attributing this to contextual or temporary causes (Lineweaver & Hertzog, 1998). Following exposure to a series of cognitively demanding memory tasks self-ratings of memory-specific competence decreased in older adults, however these showed little change or even improvement in younger adults (Bielak et al., 2007).

Older adults' ratings of self-efficacy appear to vary considerably depending on the task and are heavily influenced by negative stereotypes about aging (Desrichard & Köpetz, 2005; Lineweaver & Hertzog, 1998). Interestingly, these stereotypes may also have an impact on older adults' performance on memory tests; this has been investigated in experimental manipulations of stereotype threat. Younger and older adults were asked to complete a memory task that either emphasised or de-emphasised memory, placing older adults in a testing situation in which widely held negative age-related stereotypes were triggered undermined subsequent memory performance (Chasteen, Bhattacharyya, Horhota, Tam & Hasher, 2005). Poor memory self efficacy has also been shown to predict attendance at memory clinics in older adults with subjective memory complaints (Ramakers et al., 2009), these individuals reported greater decline in memory functioning, reduced memory capacity and were more likely to report a family history of dementia than controls.

1.3.2 Individual Consequences of MCI Diagnosis

Receiving a diagnosis of MCI has been associated with lower self confidence, anxiety and uncertainty over diagnosis (Frank et al., 2006; Joosten-Weyn Banningh, Vernooij-Dassen, Rikkert & Teunisse, 2008; Regan & Varanelli, 2013). The heterogeneous nature of MCI and the absence of an effective treatment has the potential to be overwhelming and anxiety-provoking for patients and their families (Whitehouse, 2007). As discussed previously, individuals with MCI experience high rates of co-morbid anxiety and depression, which have been shown to increase as cognitive functioning decreases (McDougall, Becker, & Arheart, 2006). Individuals with MCI report frustration and embarrassment about their memory and cognitive changes as well as feeling uncertain about their diagnosis (Frank et al., 2006). A number of researchers have suggested that the diagnostic label may itself potentially worsen psychological distress in individuals with MCI (Werner & Korczyn, 2008). The MCI diagnosis is poorly understood by patients, who often have differing attributions for their difficulties, including dementia, normal ageing or even personality traits and habits (Joosten-Weyn Banningh et al., 2008). The authors noted that many of these attributions appeared likely to further contribute to the development of anxiety or depression, which is more prevalent in individuals with MCI than cognitively unimpaired older adults. This may be particularly important for this population, where psychological distress is associated with greater likelihood of progression of cognitive impairment (Simard, Hudon, & van Reekum, 2009). While dementia may have underlying neurodegenerative causes, the experience of psychological distress and its sequelae during early cognitive impairment may lead to increased disability, reduced independence and accelerated progression to diagnostic criteria for dementia (Tran, Srivareerat, & Alkadhi, 2010).

1.4 Compensatory Strategies

1.4.1 Use of Compensatory Strategies for Subjective Memory Concerns

Despite poorer performance on memory tests and lower memory self efficacy ratings, community dwelling older people rarely feel that these changes interfere with their ability to carry out their usual activities of daily living (Hess & Pullen, 1996). It has been suggested that the type and frequency of memory errors that older adults actually experience in everyday life may be influenced by the use of external supports such as memory aids (Bouazzaoui, Isingrini, Fay, et al., 2010; Lovelace & Twohig, 1990). Compensatory strategies, including both external aids and internal strategies, have been shown to be effective in a variety of memory-impaired and non-memory impaired populations. External aids such as calendars, timers, and dosette boxes have been shown to be the most effective means of ensuring completion of everyday prospective memory tasks such as remembering appointments and to take medications on time (West, 1995). Older people perform consistently worse than younger adults in laboratory based experiments that do not allow for use of external supports, however often perform better than younger adults in prospective memory tasks in daily life where they can make use of memory aids (Henry, MacLeod, Phillips, & Crawford, 2004).

Diminished confidence in memory ability also appears to influence the selection of internal compensatory strategies for older people. For example older people with low memory confidence were found to be more likely to actively avoid cognitively demanding situations and put less effort into tasks assessing memory performance (Wells & Esopenko, 2008). While a study looking at memory reliance during a word pair association task showed that older participants were more reluctant to rely on their memories than younger participants, despite there being no

differences in performance, and instead were likely to engage in checking suggesting doubt about memory competence (Touron & Hertzog, 2004).

1.4.2 Use of Compensatory Strategies in MCI

As previously stated present treatment options for MCI are limited, current guidance encourages the use of repetition of information, the use of memory aids and increased familiarity (Alzheimer's Society, 2012). A qualitative study examining changes in daily life associated with MCI, suggested individuals with MCI developed effective external strategies to compensate for deficits (e.g. calendars and reminders) as well as altering their roles and responsibilities in daily activities and relationships (Blieszner, Roberto, Wilcox, Barham, & Winston, 2007). A study investigating the coping styles used by individuals with MCI to manage anxiety around progression of their difficulties, found that people tended to use problem-focused coping (e.g. using external and internal memory strategies to prevent forgetting) and avoidance-orientated coping (e.g. preventing their mistakes by avoiding difficult situations, hiding their difficulties from others and denying of forgetfulness) (Joosten-Weyn Banningh et al., 2008). Although it is known that individuals with amnesic MCI exhibit lower memory confidence, limited information is available about their use of internal compensatory strategies, however research with student populations has shown that manipulations of memory confidence can lead to a greater desire to engage in checking behaviours (Alcolado & Radomsky, 2011; Cuttler, Sirois-Delisle, Alcolado, Radomsky & Taylor, 2013).

Individuals with MCI have been shown to experience difficulties with prospective memory or remembering to perform intended actions in the future (Costa et al, 2010; Thompson, Henry, Rendell, Withall & Brodaty, 2010), moderate declines have also shown to be common among older people without MCI (Woods,

Weinborn, Velnoweth, Rooney, & Bucks, 2012). Examples of tasks which rely on prospective memory include remembering to take medication at the prescribed time, keep an appointment and turn off the stove (Woods, Weinborn, Velnoweth, Rooney, & Bucks, 2012; Zogg, Woods, Saucedo, Wiebe, & Simoni, 2012). Research with non clinical populations has shown that participants who received false negative feedback about their prospective memory performance report significantly higher levels of doubt and urges to check compared to those who received false positive feedback (Cuttler et al., 2013). These findings suggest that negative beliefs and diminished confidence in prospective memory can cause increased doubt and urges to engage in checking behaviour. It may be that those with a particular fear of developing a dementia will be more likely to hold negative beliefs and have diminished confidence in their prospective memory, making this group potentially more likely to engage in checking behaviours.

1.5 Interim Summary

Concerns regarding memory performance are common in older adults and more people are presenting earlier to services with either subjective memory problems or mild cognitive impairment (MCI). Although MCI is widely seen as a prodromal stage of dementia, many people do not progress to dementia even after 10 years (Mitchell & Shiri-Feshki, 2009). There has been considerable debate over the utility of the MCI diagnosis with questions over its predictive value and poor consensus between clinicians. Lower memory confidence may lead individuals to use compensatory strategies, including avoidance and checking, in an attempt to prevent episodes of forgetting, some of which may be ineffective or even unhelpful. Given that one of the defining differences between MCI and dementia is impairment in everyday functioning, avoidance of cognitively demanding situations has the

potential to lead to inappropriate or accelerated progression to diagnosis of a dementia. Similarly there is a growing body of literature showing that repeated checking paradoxically leads to decreased confidence in memory, in a number of studies attempting to test Rachman's (2002) cognitive theory of compulsive checking (van den Hout & Kindt, 2003a; Radomsky, Gilchrist & Dussault, 2006; Radomsky & Alcolado, 2010; Radomsky, Dugas, Alcolado & Lavoie, 2014).

1.6 Repeated Checking and Memory

1.6.1 Repeated Checking

Repeated checking consists of repeated verification that an act thought to prevent harm was performed or that a harmful act was not (e.g. that the door was locked or the oven was turned off). Much of the research into repeated checking has centred on its role as one of the most prevalent compulsions in obsessive-compulsive disorder (OCD), with 81% of those diagnosed reporting checking compulsions (Antony, Downue & Swinson, 1998). However a further 15% of the general population have also been shown to demonstrate sub-clinical checking compulsions (Stein et al., 1997). Research in this area has sought to explain firstly why individuals engage in checking behaviours and secondly why this checking is then repeated, often numerous times with diminishing returns to the individual in terms of a positive outcome.

Cognitive behavioural models of compulsive checking have highlighted the role of high perceived probability of serious harm and high perceived levels of personal responsibility in individuals engaging in checking behaviours (Rachman, 2002; Salkovskis 1985). Numerous studies have demonstrated that individuals with OCD have elevated perceptions of personal responsibility, make biased assessments of the probability and seriousness of possible harm and that manipulation of these

increases the likelihood of engaging in checking behaviours (Lopatka & Rachman, 1995; Rachman, 1993). It has been proposed that memory may also play an important role, given that individuals who engage in checking often experience high levels of doubt in the accuracy of their memories (Exner, Martin, & Rief, 2009)

1.6.2 The Role of Memory in Repeated Checking

It had been proposed that the memory distrust seen in individuals who engage in compulsive checking and particularly those with OCD, may be due to an objective memory impairment which they try to compensate for with excessive checking (Sher, Frost, Kushner, Crews & Alexander, 1989). Despite its intuitive appeal, no definitive evidence to support this hypothesis has been found, with reviews of the research in this area highlighting inconsistent findings for memory performance in OCD (Muller & Roberts, 2005) and in anxiety disorders in general (Coles & Heimberg, 2002) where repeated checking is prevalent. A larger study of neuropsychological deficits in OCD, including people with OCD, OCD plus a co-morbid disorder and participants with a history of OCD, also found no reliable deficits to be associated with a diagnosis of OCD on tests of memory (Simpson et al., 2006).

In addition to a more general memory deficit, it has also been hypothesised that individuals with OCD may have specific memory deficits for threat-related stimuli or activities. However studies investigating this hypothesis utilising more ecologically valid stimuli have suggested this is not the case. Tolin et al. (2001) found no evidence for memory deficits in individuals with OCD using stimuli related to their specific concerns, when compared to both anxious and non-anxious controls. While Radomsky, Rachman, and Hammond (2001) found that in conditions of both

high and low responsibility, individuals with OCD and checking compulsions actually showed improved memory accuracy for threat-related information.

1.6.3 The Role of Metamemory in Repeated Checking

Metamemory is defined as knowledge and awareness of one's own memory capabilities. This includes factors that relate to or describe memory such as memory confidence, vividness (e.g. clarity and intensity of memory) and detail (e.g. memory of particular visual features). Given the lack of consistent evidence for objective memory impairment in individuals who engage in checking, it has been proposed that the high levels of doubt reported may be due to a metamemory problem. Specifically, low confidence in memory, and that it is this rather than the accuracy of memory that plays a role in the development of checking. This lack of confidence in memory that characterises OCD, has been reliably demonstrated in a number of studies in the absence of deficits in memory accuracy (Cogle, Salkovskis, & Wahl, 2007; Macdonald et al., 1997; Tolin et al., 2001). Research with non-clinical populations has provided further support for this theory, where participants who received false negative feedback about their memory reported significantly higher levels of doubt and urges to check compared to those who received false positive feedback (Alcolado & Radomsky, 2011; Cuttler, Sirois-Delisle, Alcolado, Radomsky & Taylor, 2013). However while this explains how checking may begin, it does not explain why in many cases doubt persists for individuals even after checking.

1.6.4 Rachman's (2002) Cognitive Theory of Compulsive Checking

A growing body of literature (van den Hout & Kindt, 2003a; Radomsky, Gilchrist & Dussault, 2006) demonstrates repeated checking may paradoxically both be a consequence of and lead to further memory distrust, in a number of studies

attempting to test Rachman's (2002) cognitive theory of compulsive checking. Rachman's (2002) theory has sought to explain the processes by which checking behaviours in OCD are maintained. It proposes three cognitive 'multipliers' including increased responsibility, probability of harm and anticipated seriousness of harm which interact to initiate the checking behaviour. The checking behaviour is then maintained by a self-perpetuating mechanism, where doubt increases checking and checking increases doubt. Catastrophic misinterpretations of the significance of 'not remembering' despite checking then contribute to further escalation in checking behaviour.

Van den Hout and Kindt (2003b) hypothesised that reductions in memory confidence may be due to other aspects of metamemory, specifically vividness and detail, being affected by increased familiarity following repeated checking. Confidence in our memory for specific events has been found to be influenced by the vividness and detail of these memories (Van den Hout and Kindt, 2003b), whilst increased familiarity has paradoxically been shown to lead to less detailed and vivid recollections (Johnston & Hawley, 1994). It has been suggested that this inhibition of perceptual processing is due to processing priority being increasingly given to higher-level semantics rather than lower-level perceptual elements (such as colours or shapes). Therefore while an individual with OCD may be motivated to check by the desire to reduce uncertainty, the more they check the less detailed and vivid their recollection which negatively impacts on confidence in memory for previous checks. This likely precipitates further checking in a counterproductive attempt to regain memory vividness, detail and confidence, giving rise to the self-perpetuating mechanism described by Rachman (2002).

1.7 Experimental Studies Investigating Repeated Checking

1.7.1 Methodological Approaches to Investigating Checking Behaviour

Checking behaviour can take many forms, including ‘visual checking’, ‘mental checking’, ‘physical checking’ and reassurance seeking (Radomsky & Alcolado, 2010). Though all forms of checking are common, research has focused on investigating the effects of repeated ‘physical checking’. ‘Physical checking’ involves manipulating an object to make sure a particular action has been carried out (Radomsky & Alcolado, 2010). The majority of research studies investigating repeated checking utilise a ‘stove paradigm’ originally developed by Van den Hout and Kindt (2003a; 2003b; 2004) and later adapted by Radomsky, Gilchrist and Dussault (2006).

1.7.2 Empirical Evidence in Non-clinical Samples

The stove paradigm utilised by Van den Hout and Kindt (2003a; 2003b; 2004) in their original series of five experiments, consisted of participants being trained to ‘turn-on’, ‘turn-off’ and ‘check’ the six knobs of a virtual gas stove, as well as perform a similar sequence with virtual light bulbs. Following this training phase, participants completed a pre-checking trial, where they were asked to ‘turn-on’, ‘turn-off’ and ‘check’ a set of three knobs on the stove. Participants were then either asked to perform 20 further checking trials using the virtual stove, in the ‘relevant checking’ condition, or of the virtual light bulbs, in the ‘irrelevant checking’ condition, before completing one further post-checking trial of the stove. These experiments showed that non-clinical participants who engaged in repeated ‘relevant checking’ of the virtual gas stove, as opposed to ‘irrelevant checking’ of virtual light bulbs, had significantly decreased memory confidence, vividness and detail for a subsequent check of the virtual stove. Memory accuracy and confidence

in outcome for this final check was unaffected by the repeated 'relevant checking' trials.

Radomsky, Gilchrist & Dussault (2006) attempted to replicate and extend this finding in a laboratory based experiment using a working electric stove and sink in place of the virtual stove and lights. They hypothesised that the use of virtual stimuli presented only a limited sense of perceived threat or responsibility for the prevention of harm and therefore reduced the affect that would be generated in more ecologically valid situations. Consistent with the findings of van den Hout & Kindt (2003a; 2003b; 2004), reduced memory confidence, vividness and detail were observed following 'relevant checking' in the post-checking trial. Unlike the van den Hout and Kindt (2003a; 2003b; 2004) experiments, there was also a slight but significant decrease in memory accuracy following the post-checking trial in the 'relevant checking' condition. However as there was no manipulation check of threat or responsibility it is unclear if this inconsistency in memory accuracy between the studies is due to the improved ecological validity of the paradigm resulting in higher perceived responsibility or increased probability and severity of harm as had been proposed by Radomsky et al. (2006). Additionally the stove task in this study utilised a single removable plastic knob to operate all six hobs while the burner lights were covered (Radomsky et al., 2006). These alterations were made to the stove paradigm to prevent participants from engaging in visual checking to determine the status of the stove between trials, however may have also have artificially increased the difficulty of this task which may explain the observed differences in memory accuracy.

Despite consistent findings of reductions in metamemory, the ecological validity and extent to which either paradigm truly represents the difficulties faced by

individuals who engage in repeated checking is questionable. Due to the methodological challenges of testing the effects of repeated checking, this paradigm utilises a complex procedure with multiple checks being given over a short period of time to provide an approximation of an individual's experience of repeated checking. The stove paradigm requires participants to remember which 3 of the 6 stoves they checked on the post-test trial following multiple trials with different outcomes, rather than simply if the stove is off or if they checked the stove. Additionally although both van den Hout & Kindt (2004) and Radomsky et al. (2006) include a 'check' step, this is limited in its scope, meaning it is unclear whether these effects are due specifically to 'checking' or 'repetition'. Nevertheless these studies provide support to the hypothesis that doubt is a normal phenomenon following repeated checking, providing an insight into why compulsive checkers continue to distrust their memory despite repeated checking.

While the effects on memory accuracy remain unclear, reductions in memory confidence, vividness and detail following repeated checking are well established and have been replicated in studies utilising both virtual (Boschen & Vuksanovic, 2007; Dek et al., 2010; Medway & Jones, 2013) and functional stimuli (Coles, Radomsky & Horng, 2006; Radomsky & Alcolado, 2010; Radomsky et al., 2014). A number of studies have begun to test the limits of the repeated checking effect. Coles, Radomsky and Horng (2006) using a functional stove showed that varying the number of checking trials resulted in significant reductions in metamemory occurring after as few as 5-10 relevant checks. Additional trend analyses for this study revealed that such effects were detectable even after only two checks. At present no studies have reviewed the impact of increased checking trials on memory accuracy above the 20 trials used in the original paradigm. However a recent study

has suggested that physically 'checking' itself may not be necessary for these effects to occur and simply repeatedly using an object can have the same effects on metamemory. Medway & Jones (2013) adapted the virtual stove paradigm to compare repeated checking with repeated stimuli use, where the 'check' step was removed, and found significant reductions in memory confidence, vividness and detail as well as slight reductions in memory accuracy. This provides support for the hypothesis that reductions in metamemory may be the result of increased familiarity rather than something unique to checking and suggests that alongside other factors proposed by Rachman (2002) that repeated object use may serve as a precursor to repeated checking.

Van den Hout & Kindt (2003a; 2003b; 2004) proposed that reductions in metamemory as a result of repeated checking may be explained by coding shifting from perceptual processing to more semantic processing. This was explored in their series of experiments utilising the virtual stove paradigm, where participants who were in the relevant checking condition were more likely to report only 'knowing' which knobs they had checked rather than being able to 'remember' in comparison to participants in the irrelevant checking condition. This finding has since been replicated (Coles, Radomsky & Horng, 2006; Radomsky, Gilchrist & Dussault, 2006) providing further support for this hypothesis. Boschen, Wilson & Farrell (2011) attempted to build on this finding utilising a computerised virtual stove task where the stimulus would change colour every 5 checks, the aim of this was to test if memory distrust can be ameliorated through the use of novel stimuli. In line with this hypothesis, participants in the relevant checking condition did not experience the decrease in memory confidence, vividness and detail seen in other studies. The results of this study suggest the potential for interventions aimed at increasing the

novelty of checks may limit the effects of repeated checking or object use. However a factor that may limit their generalisability is that while distinctiveness and novelty can be easily achieved within a computerised task they may be more challenging to replicate in real life settings.

1.7.3 Empirical Evidence in Clinical Samples

Only two studies have investigated the impact of repeated checking on memory accuracy within clinical populations, both of which included participants with OCD (Boschen & Vuksanovic, 2007; Radomsky et al., 2014). Boschen & Vuksanovic (2007) compared individuals with OCD to undergraduate controls using the virtual stove paradigm under both high and low responsibility conditions. Following repeated checking individuals with OCD and controls showed similar metamemory declines and a small decrease in memory accuracy, however in the high responsibility condition where participants were told that another person would receive a mild shock each time a mistake was made, individuals with OCD showed further decline in memory confidence. Radomsky et al. (2014) compared individuals with OCD who reported primarily checking symptoms to undergraduate controls, replicating the functional stove paradigm (Radomsky et al., 2006). They found similar reductions in metamemory ratings following relevant repeated checking in both groups, in addition to small but significant declines in memory accuracy. No differences in memory accuracy were found between clinical and student participants.

These studies support Rachman's (2002) model of checking and the self-perpetuating cycle by demonstrating that participants with OCD and controls who engage in repeated checking experience similar metamemory declines. However there are a number of limitations to these studies that need to be considered when

interpreting these findings. Although Radomsky et al. (2014) specifically tested individuals with OCD primarily with checking compulsions, which is important as they may be affected differently by the process of repeated checking than individuals who engage in other compulsions, neither study used stimuli relevant to the specific concerns of the individuals with OCD. This is a potential limitation of these studies as the use of stimuli relevant to participants specific concerns may have lead to an increase in threat and responsibility. Ideographically selected compulsive actions have been shown to lead to significantly more cognitive doubt compared to neutral actions when performed by those with OCD (Hermans et al., 2008). A further methodological weakness of these studies is the selection of undergraduate controls as they do not necessarily approximate to clinical populations. A more appropriate sample could be drawn from a population of anxious controls or sub clinical checkers in order to isolate whether the effect is specific to OCD checkers.

At present no research has been conducted involving other clinical populations where reduced confidence in memory may be particularly salient, such as in cognitive impairment. Alcolado & Radomsky (2011) demonstrated that individuals with manipulated low memory confidence are more likely to have the urge to check. This would suggest this mechanism is bi-directional and there may be other clinical populations who may engage in checking behaviours, which may include individuals with either objective or subjective memory difficulties. This could also have important clinical implications for the use of memory aids with clinical populations and the circumstances under which these may reduce or improve confidence in memory.

1.8 Rationale for the Preset Study

Concerns regarding memory performance, notably prospective memory and the potential onset of dementia become increasingly common in older people (Jorm et al., 1994). Older people both with and without objective memory difficulties may engage in compensatory strategies to reduce feelings of uncertainty, including checking behaviours or a reliance on memory aids. However, the use of these compensatory strategies may paradoxically lead to reductions in memory confidence, vividness and detail as well as potential reductions in memory accuracy. This is likely to precipitate further checking in a counterproductive attempt to regain memory clarity and confidence, giving rise to a self-perpetuating mechanism, similar to that described by Rachman (2002). For some individuals reductions in memory confidence and catastrophic misinterpretations of the significance of ‘not remembering’ despite checking may be seen as a sign of further memory decline, possibly resulting in increased anxiety and the avoidance of activities. This may be of particular significance in MCI where a criterion which separates MCI diagnosis from dementia is that the difficulties do not significantly impact on daily living (Petersen, 2004). This potentially could lead to inappropriate diagnosis for these individuals (false positives) and the unnecessary use of medication, which can have serious side-effects (Winblad et al., 2008).

The present study therefore aimed to build upon previous research by adapting the paradigm used by Radomsky, Gilchrist & Dussault (2006) to investigate the effects of repeated ‘relevant’ and ‘irrelevant’ checking on memory accuracy and metamemory (memory confidence, vividness and detail) in community dwelling older people without memory problems and to pilot an investigation of this effect in a sample of individuals with mild cognitive impairment (MCI). Participants in the

'relevant checking' condition checked a non-functional replica stove while those in the 'irrelevant checking' condition checked a dosette box, before completing a final checking trial of the stove. The study also looked to test if a similar shift from "remembering" to "knowing" is reported by those engaged in repeated 'relevant checking', as reported by van den Hout & Kindt (2003a). Finally the study investigated the potential relationship between fear of developing a dementia and self reports of prospective memory, which may be particularly relevant given that diminished confidence in prospective memory can cause increased doubt and urges to engage in checking behaviour. Measures of anxiety and depression were included in the analyses as covariates, as both have been shown to impact on memory (Kizilbash, Vanderploeg & Curtis, 2002).

The study may have theoretical implications for Rachman's model of compulsive checking (2002) and the extent to which memory accuracy declines seen by Radomsky, Gilchrist & Dussault (2006) were due higher perceived threat resulting from improved ecological validity or the increased difficulty of their task. Despite the use of a non-functioning stove it is hypothesised that in this experiment the sense of threat to these participants comes as much from failing to remember as something catastrophic happening as a result of not remembering. The results of the study may also have important clinical implications for formulation and treatment development for individuals with memory concerns. Possible treatment applications of the findings could include psychoeducation and behavioural experiments to demonstrate the benefits or problems of engaging in checking for individuals with memory concerns and how best to implement memory aids such as diaries and dosette boxes.

1.9 Research Questions

1. Does repeated relevant checking lead to significantly reduced memory confidence, vividness and detail for recall in older people and people with MCI, when compared to an irrelevant checking condition?
2. Does repeated relevant checking lead to significant reductions in memory accuracy in older people and people with MCI, when compared to an irrelevant checking condition?
3. Does repeated relevant checking result in older people and people with MCI having a general sense of “knowing” that a check has been completed rather than a specific memory of completing the check?
4. Do older people and individuals with MCI with a greater apprehension about developing Alzheimer’s disease report a higher incidence of prospective memory slips in everyday life?

2.0 Methodology

2.1 Design

This study employed 2 x 2 mixed factorial experimental designs to test the above hypotheses for the older adult and MCI samples. The independent variable was checking type (relevant checking and irrelevant checking). Participants were randomly assigned to either a relevant checking or an irrelevant checking condition using permuted block randomisation and sealed envelopes. The dependent variables were measures of memory accuracy and metamemory (confidence, vividness and detail) assessed at two time points (pre-checking and post-checking).

2.2 Participants

2.2.1 Older Adult Sample

A sample of community dwelling older people without cognitive impairment were recruited from a nonclinical population. 60 years of age was chosen as the lower age range, in line with the United Nations definition of an older person (United Nations, 2013).

2.2.1.1 Inclusion and exclusion criteria

To be included in the study participants had to be aged older than 60 years and living independently in the community, fluent in English and judged capable by the researcher of giving informed consent. Participants were excluded if there was evidence or a diagnosis of cognitive impairment (including MCI and dementia). They were also excluded if they had a learning disability, physical or sensory disability that would significantly impact on their participation. Individuals receiving treatment for alcohol related problems or for OCD were also excluded from the study.

2.2.1.2 Sample size

According to a power calculation using G Power (Faul, Erdfelder, Lang, & Buchner, 2007), for a 2 X 2 MANOVA, it was estimated that, with power set at .8 and α at .05, a total of 25 participants would be required to detect an effect size of .32 (see Appendix A). A further power calculation was conducted for the second of the primary hypotheses, for a 2 X 2 ANOVA, it was estimated that, with power set at .8 and α at .05, a total of 28 participants would be required to detect an effect size of .56 (see Appendix B). Both calculations were based on effect sizes reported within the repeated checking literature (Radomsky et al., 2014).

2.2.1.3 Recruitment process

The sample of community dwelling older people without cognitive impairment were recruited through memory clinics in Norfolk and Suffolk NHS Foundation Trust (NSFT) and North East London NHS Foundation Trust (NELFT) as well as voluntary sector services in Norfolk and Suffolk. Potential participants who met the inclusion and exclusion criteria were informed of the study by clinicians/workers within these teams. If they were agreeable to being contacted regarding the study, they were asked if their name and contact details could be shared with the researcher to discuss the study in greater detail and be invited to take part.

2.2.2 MCI Sample

A community dwelling sample of individuals with MCI was recruited through memory clinics. Due to poor consensus of diagnostic criteria between clinicians as well as the use of different assessment procedures (Ward et al., 2012), participants were judged by the referring clinician to score 0.5 on the Clinical Dementia Rating Scale (CDR, Morris, 1993) and meet the Petersen (2004) criteria

for MCI. The diagnostic criteria defined by Peterson (2004) criteria are often used in clinical practice and research (Stephan et al., 2013). They define MCI as subjective/objective memory complaint, normal general cognitive function and an objective memory impairment, which is not better explained by functional impairment and does not meet the diagnostic criteria for dementia. A systematic review of research with this population suggested that 50 years old would be an appropriate lower age limit for inclusion in the study (Stephan et al., 2013).

2.2.1.1 Inclusion and exclusion criteria

To be included in the study participants had to have a current diagnosis of mild cognitive impairment (MCI) given within the last 6 months. In addition to being judged by the referring clinician to score 0.5 on the Clinical Dementia Rating Scale (CDR, Morris, 1993) and meet the Petersen (2004) criteria for MCI. To take part individuals had to be older than 50 and living in the community, as well as being fluent in English and judged capable of giving informed consent. Participants were excluded if their primary concern was anxiety (including OCD) or depression rather than cognitive impairment. Participants were also excluded if they had a learning disability, physical or sensory disability that would significantly impact on participation. Individuals receiving treatment for alcohol related problems or if this was recorded as a co-morbid issue were also excluded.

2.2.1.2 Sample size

Due to the challenges with recruitment of individuals with MCI, notably in identifying potential participants in services who reliably meet the Peterson (2004) criteria (Ward et al., 2012), as well as due to difficulties with co-morbid anxiety within this population (Palmer et al., 2007; Van der Linde, et al., 2010), the study

will attempt to pilot an investigation of this effect in a smaller sample of 14 individuals with MCI.

2.2.1.3 Recruitment process

The sample of individuals with MCI was recruited through memory clinics in Norfolk and Suffolk NHS Foundation Trust (NSFT) and North East London NHS Foundation Trust (NELFT). Potential participants who met the inclusion and exclusion criteria were informed of the study by clinicians within these teams, who were asked to consider the individual's capacity to consent to taking part in the study. If participants were agreeable to being contacted regarding the study, they were asked if their name and contact details could be shared with the researcher to discuss the study in greater detail and be invited to take part.

2.3 Experimental Task

The experimental task used in this study was adapted from an experimental protocol used in a number of laboratory based experiments utilising a real stove and tap to investigate the effects of repeated checking on memory accuracy and metamemory (Radomsky et al., 2006; Radomsky & Alcolado, 2011; Radomsky et al., 2014). The primary author of this experimental paradigm (Professor Adam Radomsky) generously provided full details of his experimental paradigm. The present study instead utilised a model stove and dosette box which served two functions. The first of these was to allow for the study materials to be easily transported to participants' homes. This was important as members of the target population were likely to have found transport to a single laboratory setting difficult. Secondly, given these tasks were originally designed to examine repeated checking as seen within OCD, this allowed for the use of tasks that were considered more ecologically valid and representative of checking within the target population.

2.3.1 Stove Task

Participants were trained to “turn-on”, then “turn-off” and finally to “check” a set of knobs on a non-functional replica stove top in a ritualised manner. To create an analogue procedure ‘out of the lab’ consistent with the Radomsky protocols, a full-scale plastic ‘stovetop’ was created for this study. The replica stovetop had six identical plastic stove knobs which could be rotated from zero to five. Each knob on the stove corresponded to one of six stove burners. During the experiment the stove knobs were referred to by numbers one to six. To ensure that participants understood which number corresponded to which knob a numbered diagram was provided to the participant (see Appendix C).

Instructions were given during each relevant checking trial to perform this series of actions on a set of three stove knobs (see Appendix D). In previous studies which utilised a real stove (Radomsky et al., 2006; Radomsky & Alcolado, 2011; Radomsky et al., 2014), the knobs were removed and replaced with a single knob to ensure that there were no visual cues that could inform the participants that the stove had been correctly turned off. It was decided that for this task the knobs would not be removed as this would artificially increase the difficulty of the task and reduce its ecological validity.

2.3.2 Dosette Box Task

All participants were trained to “open and remove the capsule”, then “close” and finally to “check” the compartments of a ‘dosette’ box or pill organiser. A dosette box was chosen as a comparator here because it was considered to have a high level of face-validity with participants. The dosette box had 28 individual compartments arranged in a seven by four configuration. The days of the week (Sunday to Saturday) were labelled along the top and each compartment was labelled

either morning, noon, evening or bed. Each compartment contained an empty coloured gelatine capsule. The individual compartments were opaque and therefore required the lid of that individual compartment to be opened to complete the check. A container was provided in which to place the gelatine capsules once removed from the dosette box. Instructions were given during each irrelevant checking trial to perform this series of actions on a single compartment of the dosette box (see Appendix E). It was decided that the increased number of potential locations in the dosette box task would allow it to be suitably complex to perform the same function as the irrelevant checking tasks involving a sink or light used in previous studies.

2.4 Measures

2.4.1 Clinical Dementia Rating Scale (CDR; Morris, 1993)

The CDR (Morris, 1993) was used to provide a rating of cognitive and functional performance and was completed by the referring clinician as part of the establishment of MCI status. The CDR is a global dementia rating scale that rates impairment in each of six domains: Memory, Orientation, Judgment and Problem Solving, Community Affairs, Home and Hobbies, and Personal Care. The CDR provides a global score that is a composite score based on an algorithm giving different weights to the scores for each of the domains. This global score is used to grade the severity of impairment and is measured using 0, 0.5, 1, 2, and 3 to denote no impairment, mild cognitive impairment or questionable dementia, mild dementia, moderate dementia, and severe dementia. It can be completed in around 3 minutes for clinicians already familiar with individual cases (see Appendix F). The CDR demonstrates good overall inter-rater reliability ($\kappa = .62$).

2.4.2 Geriatric Anxiety Inventory Short Form (GAI-SF; Byrne & Pachana, 2011)

The GAI-SF (Byrne & Pachana, 2011) is used to detect the presence of anxiety. The GAI-SF is a five item self report questionnaire which can be completed in between 1 and 2 minutes (see Appendix G). A score of three or greater is considered optimal for the detecting DSM-IV Generalized Anxiety Disorder (GAD). The GAI-SF has demonstrated a sensitivity of 75%, specificity of 87%, and positive predictive value of 86%. GAI-SF score was not related to age, MMSE score, level of education or perceived income adequacy. Internal consistency is high (Cronbach's $\alpha=.81$) and concurrent validity against the State-Trait Anxiety Inventory is good ($r_s = .48, p < .001$).

2.4.3 5-item Geriatric Depression Scale (5-item GDS; Hoyle et al., 1999)

The 5-item GDS (Hoyle et al., 1999) is used to detect the presence of depression. The 5-item GDS is a five item questionnaire which can be completed in between 1 and 2 minutes (see Appendix H). A score of two or higher indicates possible depression. The 5-item GDS has demonstrated a sensitivity of 94%, specificity of 81%, and positive predictive value of 81%. The 5-item GDS shows a significant agreement with the clinical diagnosis of depression ($\kappa = .74$). The 5-item GDS had good inter-rater reliability ($\kappa = .88$) and test-retest reliability ($\kappa = .84$).

2.4.4 6-Item Cognitive Impairment Test (6-CIT; Brooke & Bullock, 1999)

The 6-CIT (Brooke & Bullock, 1999) is used to assess cognition. The 6-CIT is a six item questionnaire which can be completed in around 3 minutes (see Appendix I). A score of eight or lower indicates possible impairment. The 6-CIT has

demonstrated sensitivity for dementia of 92.1% and specificity of 95.6%. The 6-CIT was found to correlate strongly with the MMSE ($r^2 = .911$).

2.4.5 Prospective and Retrospective Memory Questionnaire (PRMQ; Crawford, Smith, Maylor, Della Sala, & Logie, 2003)

The PRMQ (Crawford et al., 2003) is used to provide a self-report measure of prospective and retrospective memory slips in everyday life (see Appendix J). It consists of sixteen items, eight asking about prospective memory failures, and eight concerning retrospective failures. The questionnaire takes around 5 minutes to complete. Answers are completed with a five point likert scale ranging from “never” to “very often.” The PRMQ shows high internal consistency, with the reliability on Cronbach's alpha being .89 for the total scale, .84 for prospective memory scale, and .80 for the retrospective memory scale (Crawford, Henry, Ward, & Blake, 2006).

2.4.6 Item Adapted from the Fear of Developing Alzheimer's Disease Scale (FADS; French et al., 2012)

An item adapted from The Fear of Alzheimer's Disease Scale (FADS; French, Floyd, Wilkins, & Osato, 2012) was used to assess apprehension about developing Alzheimer's disease (see Appendix K). The original questionnaire consists of 30 likert scale items and can be completed in around 5 minutes. Internal consistency was high (Cronbach's $\alpha = .94$) and concurrent validity against the State-Trait Anxiety Inventory was good ($r = .216, p = .03$). This study used only item 9 from this questionnaire - “I think that I will probably get Alzheimer's disease, and it frightens me”, with participants being asked to rate how much they agree with this statement on a four point likert scale.

2.4.7 Additional Questions

An additional questionnaire was used to obtain demographic information from participants in each sample (See Appendix L). The following information was recorded; age, gender, ethnicity, marital status, highest qualification achieved, current/previous occupation, and current medications. Participants were asked additionally to provide self report ratings of quality of life and of physical health using a four point likert scale.

2.4.8 Experimental Task Measures

These measures were administered following both the initial check (See Appendix M) and again following the final check of the stove (See Appendix N). These measures were the same as those used in van den Hout and Kindt's (2003a, 2003b, 2004) original series of experiments.

2.4.8.1 Memory accuracy

Participants were asked to indicate on a schematic drawing of the stove top, which three burners they had been asked to check during the most recent checking trial. Memory accuracy scores were the number of stove knobs (scored out of three) correctly recalled.

2.4.8.2 Memory confidence

Participants were asked to rate how confident they were that the three burners they had indicated were those they had been asked to check during the most recent checking trial, on a scale of 0 to 100. Participants were told that a score of 0 represents "not at all confident" and that a score of 100 represents "extremely confident".

2.4.8.3 Vividness and detail

Participants were asked to rate the vividness and detail of their memory for the most recent checking trial on a scale of 0 to 100. Participants were told that vividness

refers to the clarity and intensity of their recollection, while detail refers to their ability to remember particular visual features of the last checking trial. Participants were told that a score of 0 represents “not at all” and that a score of 100 represents “extremely”.

2.4.8.4 “Remembering” vs. “knowing”

Participants were asked to indicate whether their memory for the most recent trial was consistent with “remembering” the event, or just “knowing” that it happened. A description of this distinction, adapted from Radomsky et al., (2006), was provided to them. Participants were told that: “Knowing” that the knobs are all off means that you have a general sense that they are off. Even if you do not have a concrete memory, you just know they are turned off. For example, your memory of tying your shoes this morning is probably “known” as opposed to “remembered”. “Remembering” that the knobs are turned off means you can go through your memory and bring up a memory of the act (with specific features) of turning them off. For example, your memory of meeting me for the first time today is probably “remembered” as opposed to just “known”.

2.5 Ethical Considerations

Ethical approval to conduct this study was obtained from the NRES East of England – Essex Research Ethics Committee (Appendix O).

2.5.1 Consent

Potential participants were not approached to take part in the study unless they had given their consent to be contacted. Information sheets for the study were given to potential participants at least 24 hours in advance of taking part in the study (see Appendix P), so that they had sufficient time to give their informed consent to participate. In addition to containing details about the study and what would be required if they choose to participate, the information sheet also explained issues

around confidentiality and data protection. Permission was also sought to inform the participants' General Practitioners that they were taking part in the study (see Appendix Q). Prior to beginning the experiment, participants were asked to complete a consent form (see Appendix R) and were reminded of the voluntary nature of the study as well as their right to withdraw at any time without it affecting their care.

2.5.2 Distress

It was anticipated that some participants might experience some distress or concerns around their memory. This was addressed within the participant information sheet and was discussed with participants both prior to and after taking part. Any cases where a participant reported significant concerns around their memory, they would be signposted to their GP. Following completion of the task and questionnaires, participants were debriefed (Appendix S) and any questions or concerns the participant had about the research were addressed. If there were any signs of distress during the assessment, participants were reminded that participation was voluntary and that they were free to withdraw at any point. Any incidents of distress were also noted in the research logbook and discussed with the primary research supervisor.

2.5.3 Data Storage

Consent forms and measures were stored securely and separately from one another to maintain participant confidentiality. Each participant was allocated a unique identification number to allow for data relating to the study to be anonymised. Statistical data relating to the study was stored on an encrypted memory stick and could only be accessed by individuals involved in the project. Upon completion of the study, consent forms and measures will be stored in a locked

archive room at the University of East Anglia for 10 years, in line with UEA research Data Management Policy, following which they will be destroyed.

2.6 Procedure

The sample of older people was recruited through memory clinics in Norfolk and Suffolk NHS Foundation Trust (NSFT) and North East London NHS Foundation Trust (NELFT) and voluntary sector services in Norfolk and Suffolk. The sample of individuals with MCI was recruited through memory clinics in Norfolk and Suffolk NHS Foundation Trust (NSFT) and North East London NHS Foundation Trust (NELFT). Managers and clinicians of potential contributing sites were contacted via telephone or email to inform them of the research and the process for identifying eligible individuals for the study. Potential participants who met the inclusion and exclusion criteria were informed of the study by clinicians within these teams. If participants were agreeable to being contacted regarding the study, they were asked if their name and contact details could be shared with the researcher to discuss the study in greater detail and be invited to take part. The researcher then contacted potential participants and briefly outlined the study and the participant information sheet (Appendix P) was posted to them, this is outlined in telephone script 1 (Appendix T). If agreeable participants were then contacted after a few days to book the appointment as well as to answer any questions they may have at this stage of the process, this is outlined in telephone script 2 (Appendix T).

Participants were tested individually at a location of their choice, including a bookable room at UEA or a quiet location within their home. Participants were reimbursed for travel to and from the assessment if they choose to have this at a location other than their home. All meetings complied with Norfolk & Suffolk NHS Foundation Trust (NSFT) and UEA lone working policy. During the assessment the

participant information sheet (Appendix P) was reviewed and the individual had an opportunity to ask any remaining questions. If they were happy to proceed, participants were then asked to complete a consent form (see Appendix R). Once participants had given their informed consent to take part in the study, the researcher allocated a sequential study serial number and determined their random allocation.

There were four potential allocation groups to which participants could be randomised which were combinations of the two checking conditions (relevant/irrelevant checking) and the order of training phase (stove-dosette box/dosette box-stove). A blocked randomisation method was used, with random permuted blocks of either four or eight. Randomisation was administered by a staff member within the Department of Clinical Psychology at UEA independent of the research study, using Sealed Envelope (www.sealedenvelope.com). The allocations for the older adult and MCI samples were held in two separate sets of opaque sealed envelopes which corresponded to the allocated study serial numbers and were held by another individual independent of the research. The allocation was not revealed to the researcher until after the consent process had been completed, at which point the researcher contacted this individual to request the opening of the sealed envelope corresponding to the participants allocated study serial number.

Participants were trained how to check either the stove followed by the dosette box or the dosette box followed by the stove, with this counterbalanced between participants. Participants were trained to “turn-on”, “turn-off” and then “check” the complete set of knobs on the stove in a standardised fashion. To perform a check participants were required to physically manipulate the knobs to ensure that they were in the off position. They were also trained to “open”, “remove the capsule”, “close” and then “check” a compartment of a dosette box in a standardised

fashion. To check the compartment of the dosette box the participants were required to open and then close the lid of the compartment. Participants were informed that following the training phase the researcher would not be giving feedback for any of the remaining tasks.

Following this participants completed the pre-checking trial where they were asked to “turn-on”, then “turn-off” and finally to “check” a set of three knobs on the stove according to the procedures that they had just learned. All instructions were given verbally to participants. The stove stimulus was then removed from view of the participant. Participants were then asked to indicate the three knobs they had checked, to rate their confidence, vividness and detail of their memory for this check (on a scale of 0-100) in addition to whether they remembered checking or just knew they had checked on a response sheet (see Appendix M).

Participants were randomly assigned to either the relevant checking condition, where they completed an additional 15 sets of trials using the stove, or the irrelevant checking condition, where they instead completed 15 sets of trials using the dosette box. 15 repeated checking trials were chosen as previous research has demonstrated that significant reductions in metamemory occur after as few as five to ten checks (Coles et al., 2006). Each trial had a “turn-on/open and remove the capsule”, “turn-off/close” and a “check” instruction for a randomised set of three knobs or a randomised individual compartment on the dosette box and there were two lists detailing the order of these that was used to provide instructions to participants (Appendix D, Appendix E). Following each instruction, the experimenter waited for the participant to complete each task within a trial before continuing.

After completion of these trials, all participants were given a final post-checking trial where they were again asked to “turn-on”, then “turn-off” and finally to “check” a set of three knobs on the stove, following which the stove stimulus was removed from view of the participant. Participants once again were asked to indicate which three knobs they had checked on the most recent trial, whether they remember or just know that they checked as well as rating their memory confidence, vividness and detail of their memory for this final check on a response sheet (see Appendix N). A detailed outline and script for the experimental procedure is given in Appendix U.

Following this, all participants were asked to complete a questionnaire package including demographic information, a measure of cognition (6-CIT, Brooke & Bullock, 1999), self-report measures of symptoms of depression (5-item GDS, Hoyl et al., 1999) and anxiety (GAI-SF, Byrne & Pachana, 2011), of prospective and retrospective failures in everyday life (PRMQ, Crawford et al., 2003) and an item adapted from the Fear of Developing Alzheimer’s Disease Scale (FADS; French et al., 2012) (see Appendix K). Following completion of these tasks participants were given the follow up information sheet (Appendix S), which provided further information about the project and details for whom the participant should contact if they wanted further information. Participants were then given an opportunity to ask questions, feedback to the researcher and were thanked for their participation. In total, involvement in the study lasted approximately 1 hour. Following this, a letter was sent to the participant’s GP to confirm their participation and provide information on the study (Appendix Q).

3.0 Results

This chapter begins by outlining the treatment of the data and providing basic information on the demographic characteristics of the older adult and MCI samples. Descriptive data for all variables, in the main analyses are provided, with consideration given to the normality of distributions. Comparisons between experimental conditions on potential confounding variables for both samples are reported. The primary research questions are explored by testing the effect of experimental condition (relevant checking and irrelevant checking) on all dependent variables (memory accuracy, memory confidence, vividness and detail). Further analyses are then reported exploring the secondary research questions. Due to challenges with recruitment it is acknowledged that a number of inferential statistical tests are under-powered as a result and as such caution is advised when interpreting the findings.

3.1 Treatment of Data

The data was entered into SPSS (Version 22) and screened for errors, missing values, and out of range responses in the raw data. To rule out any mistakes in the data entry process all unusual responses were checked against responses in the raw data. There were no missing data.

3.2 Demographics

The demographics of both the older adult and MCI samples and of each experimental condition (relevant or irrelevant checking) were explored and are displayed in Table 1. The mean age of participants in the community dwelling non-clinical older adult sample was 73.25 years, with a standard deviation of 4.80 years and an age range for this sample of 64 to 83. The majority of the sample were white British (80%), with the remainder of the sample consisting of, any other white

background (10%) and Asian (10%). A total of 60% of the sample had undertaken some form of further education following leaving school, while the remaining 40% had no further qualification after leaving school. The majority of the sample rated their quality of life (70%) and physical health (55%) as good or excellent opposed to fair or poor.

The MCI sample had a mean of 70.21 years, with a standard deviation of 9.15 years and an age range of this sample was 51 to 81. Similarly the majority of the sample were white British (71.4%), with the remainder of the sample consisting of, Asian (21.3%) and any other white background (7.1%). 57.1% of the sample had undertaken some form of further education following leaving school, while the remaining 42.9% had received no further qualifications after leaving school. The majority of the MCI sample rated their quality of life (100%) and physical health (57.1%) as good or excellent opposed to fair or poor.

Table 1
Demographics for the older adult and MCI samples

	<i>n</i>	Males	Females	Mean age in years (SD)
Older adults sample	20	10	10	73.25 (4.80)
Relevant checking	10	4	6	71.90 (3.32)
Irrelevant checking	10	6	4	74.60 (5.80)
MCI sample	14	4	10	70.21 (9.15)
Relevant checking	7	1	6	70.14 (8.80)
Irrelevant checking	7	3	4	70.29 (10.19)

Note. *n*=number of participants. SD=Standard Deviation. MCI= Mild Cognitive Impairment.

Data for the two samples were compared on variables of age, gender, marital status educational level, physical health status and quality of life to test for differences between the groups. In addition a number of psychological measures including self reported memory failures, cognition and symptoms of anxiety and depression. To account for multiple comparisons and reduce the chance of type I

error this analysis used a Bonferroni adjustment, with a corrected p value of .005. There were no significant differences between the older adult and MCI sample on age, ($U = 124.50, p = .59$), gender ($\chi^2 = 1.56, p = .21$), marital status ($\chi^2 = 2.138, p = .54$), level of education ($\chi^2 = .971, p = .32$), self reported health status ($\chi^2 = .486, p = .48$) and quality of life ($\chi^2 = 5.100, p = .02$). There was however, a significant difference found between the groups in terms of apprehension about dementia ($\chi^2 = 8.993, p = .003$), with significantly more individuals in the MCI group reporting worry about developing dementia. The MCI sample also were more impaired on the 6-CIT ($U = 243.00, p < .001$) and scored higher on the PRMQ ($U = 231.50, p = .001$). There were no significant differences between the older adult and MCI sample on scores of the GAI-SF, ($U = 124.50, p = .88$), 5-item GDS ($U = 155.50, p = .59$)

3.3 Descriptive Data

3.3.1 Geriatric Anxiety Inventory Short Form (GAI-SF)

Descriptive statistics for the GAI-SF total score are presented in Table 2 for each experimental condition (relevant or irrelevant checking) for both the older adult and MCI samples. The distribution of the data in the older adult sample did not indicate significant skew or kurtosis. The MCI sample irrelevant checking condition indicated significant positive skew ($z = 2.29, p < .05$) and significant positive kurtosis ($z = 2.37, p < .05$). However given the small sample sizes in this study, it is recommended that the criterion for significant skew and kurtosis should be raised to $p < .01$ (Clark-Carter, 2004; Field, 2013). No significant outliers were identified using the method recommended by Clark-Carter (2004) to identify potential outliers with a standardised score greater than 3 or less than -3. Therefore the data were considered to meet the assumptions for normal distribution and not to require transformation.

Table 2
Descriptive statistics for the GAI-SF

	<i>n</i>	Min-max	Mean	SD	Skewness	Kurtosis
Older adult sample	20	0-4	1.50	1.57	.406	-1.44
Relevant checking	10	0-4	1.10	1.37	1.08	.61
Irrelevant checking	10	0-4	1.90	1.73	-.13	-2.01
MCI sample	14	0-5	1.57	1.70	1.24*	.67
Relevant checking	7	0-5	1.71	1.80	1.07	.70
Irrelevant checking	7	0-5	1.43	1.71	1.83*	3.77*

Note. GAI-SF= Geriatric Anxiety Inventory Short Form. SD=Standard Deviation. *n*=number of participants. MCI= Mild Cognitive Impairment.

* $p < .05$

3.3.2 5-item Geriatric Depression Scale (5-item GDS)

Descriptive statistics for the 5-item GDS total score are presented in Table 3 for each experimental condition (relevant or irrelevant checking) for both the older adult and MCI samples. There were no significant outliers with a standardised score greater than 3 or less than -3 identified in either sample. The distribution of the data in the MCI sample did not indicate significant skew or kurtosis. The older adult sample relevant checking condition indicated positive skew ($z = 2.10, p < .05$) however as this was not to the $p < .01$ level (Clark-Carter, 2004; Field, 2013) the data were considered to meet the assumptions for normal distribution and to not require transformation to reduce bias.

Table 3
Descriptive statistics for the 5-item GDS

	<i>n</i>	Min-max	Mean	SD	Skewness	Kurtosis
Older adult sample	20	0-3	.75	1.07	1.13*	-.10
Relevant checking	10	0-3	.70	1.06	1.44*	1.26
Irrelevant checking	10	0-3	.80	1.36	1.05	-.39
MCI sample	14	0-3	.86	.95	.95	.34
Relevant checking	7	0-2	.71	.76	.60	-.35
Irrelevant checking	7	0-3	1.00	1.16	.91	-.15

Note. GDS= Geriatric Depression Scale. *n*=number of participants. SD=Standard Deviation. MCI= Mild Cognitive Impairment.

* $p < .05$

3.3.3 6-Item Cognitive Impairment Test (6-CIT)

The descriptive statistics for the 6-CIT total score are presented in Table 4 for each experimental condition (relevant or irrelevant checking) for both the older adult and MCI samples. The distribution of the data in the MCI sample did not indicate significant skew or kurtosis. The older adult sample relevant checking condition indicated positive skew ($z = 2.10, p < .05$). However as neither condition indicated significant skew or kurtosis at the $p < .01$ significance level (Clark-Carter, 2004; Field, 2013) and none of the conditions contained significant outliers the data were considered to meet the assumptions for normal distribution.

Table 4
Descriptive statistics for the 6-CIT

	<i>n</i>	Min-max	Mean	SD	Skewness	Kurtosis
Older adult sample	20	0-6	1.50	1.07	1.17*	-.04
Relevant checking	10	0-4	1.20	1.93	1.04	-1.22
Irrelevant checking	10	0-6	1.40	2.12	1.44*	1.26
MCI sample	14	2-8	1.57	1.70	.43	-.94
Relevant checking	7	2-8	4.29	2.69	.80	-1.28
Irrelevant checking	7	4-8	5.14	1.57	1.12	.27

Note. 6-CIT= 6-Item Cognitive Impairment Test. *n*=number of participants. SD=Standard Deviation. MCI= Mild Cognitive Impairment.

* $p < .05$

3.3.4 Prospective and Retrospective Memory Questionnaire (PRMQ)

The PRMQ contains both a subscale for prospective memory and a subscale for retrospective memory as well as producing a total combined score. Descriptive statistics for the PRMQ subscales are presented in Table 5 for each experimental condition (relevant or irrelevant checking) for both the older adult and MCI samples. Scores for the MCI sample irrelevant checking condition showed evidence of positive skew ($z = 2.38, p < .05$) and kurtosis ($z = 2.11, p < .05$) for the prospective

memory subscale. However as z-scores for skewness and kurtosis were not significant at the $p < .01$ level (Clark-Carter, 2004; Field, 2013), the data could be considered to be normally distributed and not to require transformation to correct for bias.

Table 5
Descriptive statistics for the subscales and total score of the PRMQ

	<i>n</i>	Min-max	Mean	SD	Skewness	Kurtosis
Prospective memory subscale of PRMQ						
Older adult sample	20	9-22	15.60	3.75	-.07	-.42
Relevant checking	10	12-22	17.50	3.50	-.23	-1.10
Irrelevant checking	10	9-17	13.70	3.06	-.67	-1.08
MCI sample	14	14-37	21.50	6.21	1.20*	.60
Relevant checking	7	14-27	20.86	5.56	-.07	-2.38
Irrelevant checking	7	17-37	22.14	7.20	1.89*	3.35*
Retrospective memory subscale of PRMQ						
Older adult sample	20	8-21	13.75	3.96	.51	-.68
Relevant checking	10	10-21	14.50	4.04	.74	-.62
Irrelevant checking	10	8-20	13.00	3.94	.39	-1.00
MCI sample	14	12-32	19.14	5.57	.92	.57
Relevant checking	7	14-26	19.43	4.54	.15	-1.59
Irrelevant checking	7	12-32	18.86	6.82	1.36	1.76
PRMQ total score						
Older adult sample	20	17-43	29.35	6.98	.21	.08
Relevant checking	10	22-43	32.00	6.55	.75	.38
Irrelevant checking	10	17-37	26.70	6.65	-.08	-1.33
MCI sample	14	28-69	40.64	11.17	1.31*	1.87
Relevant Checking	7	28-52	40.29	9.55	.11	-2.07
Irrelevant checking	7	30-69	41.00	13.38	1.89*	3.93*

Note. PRMQ= Prospective and Retrospective Memory Questionnaire. *n*=number of participants. SD=Standard Deviation. MCI= Mild Cognitive Impairment.

* $p < .05$

3.3.5 Measure of memory confidence

Van den Hout & Kindt's (2003) original paradigm made use of visual analogue scales to measure memory confidence, vividness and detail while more recent studies have made use of ratings from 0 to 100 (Coles et al., 2006; Radomsky

et al., 2014). Considerable debate exists over the extent to which these should be considered interval or ordinal data (Clark-Carter, 2004; McDowell, 2006), however the majority of studies (Coles et al., 2006; Radomsky et al., 2014) investigating this paradigm have treated the data as interval, with the three metamemory variables analysed using 2 x 2 MANOVA to understand the potential interaction of the conditions. As the aim of this study is to attempt to replicate these previous findings within a new population, for the purposes of this comparison across studies the data for memory confidence, vividness and detail will be reported using parametric analyses and as such will be treated as if it is interval and if it meets assumptions, will be analysed using parametric tests.

Descriptive data for memory confidence pre- and post-repeated checking for each experimental condition (relevant or irrelevant checking) for both the older adult and MCI samples are presented in Table 6. There were no significant outliers with a standardised score greater than 3 or less than -3 identified in either sample (Clark-Carter, 2004). Scores for the MCI sample irrelevant checking condition post-repeated checking showed evidence of negative skew ($z = -2.23, p < .05$) and positive kurtosis ($z = 2.33, p < .05$). Scores for the older adult sample relevant checking condition pre-checking showed evidence of negative skew ($z = -2.55, p < .05$). As z scores for skewness and kurtosis were not significant at the $p < .01$ level, data were considered to meet the assumptions for normal distribution (Clark-Carter, 2004; Field, 2013).

Table 6
Descriptive statistics for pre- and post-checking memory confidence scores

	<i>n</i>	Min- max	Mean (SD)	Median (IQR)	Skewness	Kurtosis
Pre-repeated checking						
Older adult sample	20					
Relevant checking	10	80-100	95.80 (8.35)	100.00 (7)	-1.76*	1.35
Irrelevant checking	10	75-100	93.00 (8.88)	95.00 (13)	-1.32	.69
Post-repeated checking						
Older adult sample	20					
Relevant checking	10	50-95	74.50 (12.35)	77.50 (13)	-.63	1.15
Irrelevant checking	10	70-100	93.00 (10.33)	97.50 (13)	-1.60	1.81
Pre-repeated checking						
MCI sample	14					
Relevant checking	7	80-100	90.00 (10.00)	90.00 (20)	.00	-2.60
Irrelevant checking	7	70-100	89.29 (10.97)	90.00 (20)	-.94	.19
Post-repeated checking						
MCI sample	14					
Relevant checking	7	50-85	66.43 (16.00)	70.00 (30)	-.106	-2.51
Irrelevant checking	7	65-100	90.71 (12.39)	90.00 (10)	-1.79*	3.69*

Note. *n*=number of participants. SD=Standard Deviation. IQR=Interquartile Range. MCI=Mild Cognitive Impairment.

* $p < .05$

3.3.6 Measure of memory vividness

Table 7 presents descriptive data for memory vividness pre- and post-repeated checking for each experimental condition (relevant or irrelevant checking) for both the older adult and MCI samples. The distribution of the data in the MCI sample did not indicate significant skew or kurtosis at the $p < .01$ level.

Pre-repeated checking scores for the relevant checking condition of the older adult sample, indicated significant negative skew ($z = -2.98, p < .01$) and positive kurtosis ($z = 3.03, p < .01$). Post-relevant repeated checking scores in the older adult sample also demonstrated significant negative skew ($z = -3.74, p < .001$) and positive kurtosis ($z = 5.30, p < .001$). This was addressed using Winsorizing to reduce the impact of bias by substituting significant outliers to the next lowest value minus one

(Field, 2013). Examination of outliers showed a participant in the older adult irrelevant condition to have a significantly lower score, changing this participants scores reduced the pre-repeated checking skew ($z = -1.86$) and kurtosis ($z = 0.03$) to non significant levels. The post-repeated checking score for this participant was changed to keep the change difference the same for this participant, this improved skew ($z = -2.32, p < .05$) and kurtosis ($z = 1.67$) to non significant ($p < .01$) levels for the post-checking condition.

The same method was used to address a single outlier for a pre- repeated checking score in the relevant checking condition of the older adult sample, which improved significantly negative skew ($z = -3.02, p < .01$ to $z = -2.00, p < .05$) and significant positive kurtosis ($z = 3.04, p < .01$ to $z = 0.13$). There were no other significant outliers and the resulting data were considered to meet the assumptions for normal distribution and used in the analysis.

Table 7
Descriptive statistics for pre- and post-checking memory vividness scores

	<i>n</i>	Min- max	Mean (SD)	Median (IQR)	Skewness	Kurtosis
Pre-repeated checking						
Older adult sample	20					
Relevant checking	10	60-100	93.00 (13.38)	100.00 (13)	-2.08**	4.06**
Irrelevant checking	10	60-100	92.50 (13.18)	100.00 (13)	-2.05**	4.05**
Post-repeated checking						
Older adult sample	20					
Relevant checking	10	40-95	68.50 (17.80)	72.50 (25)	-.25	-1.07
Irrelevant checking	10	60-100	93.50 (12.48)	100.00 (10)	-2.57***	7.08***
Pre-repeated checking						
MCI sample	14					
Relevant checking	7	90-100	95.71 (4.50)	95.00 (10)	-.35	-1.82
Irrelevant checking	7	75-99	89.86 (7.43)	90.00 (5)	-1.36	3.26*
Post-repeated checking						
MCI sample	14					
Relevant checking	7	25-85	60.00 (21.41)	60.00 (40)	-.62	-.47
Irrelevant checking	7	75-100	88.57 (8.52)	90.00 (15)	-.51	-.26

Note. *n*=number of participants. SD=Standard Deviation. IQR=Interquartile Range.

MCI=Mild Cognitive Impairment.

* $p < .05$, ** $p < .01$, *** $p < .001$

3.3.7 Measure of memory detail

Table 8 presents descriptive data for memory detail pre- and post-repeated checking for each experimental condition (relevant or irrelevant checking) for both the older adult and MCI samples. The distribution of the data in the MCI sample did not indicate significant skew or kurtosis at the $p < .01$ level.

Scores for the older adult sample irrelevant checking condition pre-repeated checking indicated significant negative skew ($z = -2.68, p < .01$). Older adult post-irrelevant repeated checking scores also demonstrated significant negative skew ($z = -3.74, p < .001$) and positive kurtosis ($z = 5.30, p < .001$). To address skewness and kurtosis the sample was examined for significant outliers and these values were substituted for the next lowest value minus one (Field, 2013). Examination of outliers showed a participant in the older adult irrelevant condition to have a significantly lower score, changing this value reduced the skew ($z = -1.51$) in the pre-repeated checking condition to a non significant level. Due to pre- and post-checking scores being within subjects variables the post-repeated checking score for this participant was changed to keep the change difference the same for this participant, this improved skew ($z = -2.33, p < .05$) and kurtosis ($z = 1.67$) to non significant ($p < .01$) levels for the post-checking condition.

The same method was used to address a single outlier identified in the older adult sample relevant checking condition pre-repeated checking which improved significantly negative skew ($z = -3.02, p < .01$ to $z = -2.00, p < .05$) and significant positive kurtosis ($z = 3.04, p < .01$ to $z = 0.13$). There were no other significant outliers and the resulting data were considered to meet the assumptions for normal distribution.

Table 8
Descriptive statistics for pre- and post-checking memory detail scores

	<i>n</i>	Min- max	Mean (SD)	Median (IQR)	Skewness	Kurtosis
Pre-repeated checking						
Older adult sample	20					
Relevant checking	10	60-100	93.00 (13.38)	100.00 (13)	-2.08**	4.06**
Irrelevant checking	10	60-100	92.00 (13.38)	100.00 (16)	-1.84**	3.14*
Post-repeated checking						
Older adult sample	20					
Relevant checking	10	40-95	70.50 (16.58)	72.50 (22)	-.57	-.07
Irrelevant checking	10	60-100	93.50 (12.48)	100.00 (10)	-2.57***	7.08***
Pre-repeated checking						
MCI sample	14					
Relevant checking	7	80-100	92.86 (8.09)	95.00 (15)	-.67	-1.15
Irrelevant checking	7	75-99	89.14 (7.08)	90.00 (0)	-1.23	3.78*
Post-repeated checking						
MCI sample	14					
Relevant checking	7	25-100	65.00 (25.66)	70.00 (40)	-.41	-.50
Irrelevant checking	7	75-100	88.57 (8.52)	90.00 (15)	-.51	-.26

Note. *n*=number of participants. SD=Standard Deviation. IQR=Interquartile Range. MCI=Mild Cognitive Impairment.

* $p < .05$, ** $p < .01$, *** $p < .001$

3.4 Baseline Differences between the Experimental Conditions

Data for the two experimental conditions (relevant or irrelevant checking) from both the older adult and MCI samples were compared on variables of age, gender, marital status educational level, physical health status and quality of life to test for differences at baseline resulting from the random allocation. Baseline group comparisons of gender, quality of life, physical health status, marital status and educational level were made using a series of Pearson's chi square analyses, in cases where expected frequencies were less than five, Fisher's exact probability test was used (Field, 2013). In addition a number of psychological measures including self reported memory failures, cognition and symptoms of anxiety and depression were compared between the experimental conditions.

There were found to be no significant differences between relevant and irrelevant checking conditions in the older adult sample on age, ($t(18) = .128, p = .22$), gender (Fisher's exact test (2-sided), $p = .66$), marital status ($\chi^2 = 1.067, p = .59$), level of education (Fisher's exact test (2-sided), $p = 1.00$), self reported health status (Fisher's exact test, $p = .37$ (2-sided) and quality of life (Fisher's exact test (2-sided), $p = 1.00$). There were no significant differences between the relevant and irrelevant checking conditions in the older adult sample on scores of the GAI-SF, ($U = 36.50, p = .28$), 5-item GDS ($U = 48.50, p = .91$), 6-CIT ($U = 46.50, p = .76$) and PRMQ ($U = 30.50, p = .14$).

Similarly there were found to be no significant differences between the relevant and irrelevant checking conditions in the MCI sample in age, ($t(12) = -.028, p = .98$), gender (Fisher's exact test (2-sided), $p = .56$), marital status ($\chi^2 = 3.00, p = .39$), level of education (Fisher's exact test (2-sided), $p = .59$), self reported health status (Fisher's exact test, $p = .59$ (2-sided) and quality of life with all 14 participants rating quality of life good or excellent. There were no significant differences between the relevant and irrelevant checking conditions in the older adult sample on scores of the GAI-SF, ($U = 22.00, p = .74$), 5-item GDS ($U = 22.00, p = .73$), 6-CIT ($U = 17.00, p = .31$) and PRMQ ($U = 23.50, p = .90$).

3.5 Research Questions

3.5.1 Research Question 1: Does repeated relevant checking lead to significantly reduced memory confidence, vividness and detail for recall in older people and people with MCI, when compared to an irrelevant checking condition?

The first research question sought to examine whether relevant checking led to significant reductions in memory confidence, vividness and detail in the older

adult and MCI samples. Descriptive information regarding mean scores for the older adult sample for memory confidence vividness and detail are displayed in Table 9.

Table 9
Descriptive data for memory confidence, vividness and detail in older adult sample

	Confidence Mean (SD)	Vividness Mean (SD)	Detail Mean (SD)
Pre-repeated checking			
Relevant checking	95.80 (8.35)	94.90 (8.70)	94.90 (8.70)
Irrelevant checking	93.00 (8.88)	94.40 (8.51)	93.90 (8.94)
Post-repeated checking			
Relevant checking	74.50 (12.35)	70.40 (15.26)	72.40 (13.49)
Irrelevant checking	93.00 (10.33)	95.40 (7.11)	95.40 (7.11)

Note. SD=Standard Deviation.

Given the small sample sizes achieved within this study, planned statistical tests using a 2 x 2 MANOVA to combine the analysis of these variables for theoretical reasons as part of a wider construct ‘metamemory’ were not attempted. When working with small sample sizes univariate approaches are preferred over multivariate approaches as they tend to be more powerful (Field, 2013). Instead three separate 2 x 2 repeated measures ANOVAs were conducted on the individual dependent variables that make up metamemory (memory confidence, vividness and detail). Figure 1 represents the interactions being investigated by these tests. To account for multiple comparisons and reduce the chance of type I error this analysis used a Bonferroni adjustment, with a corrected p value of .017.

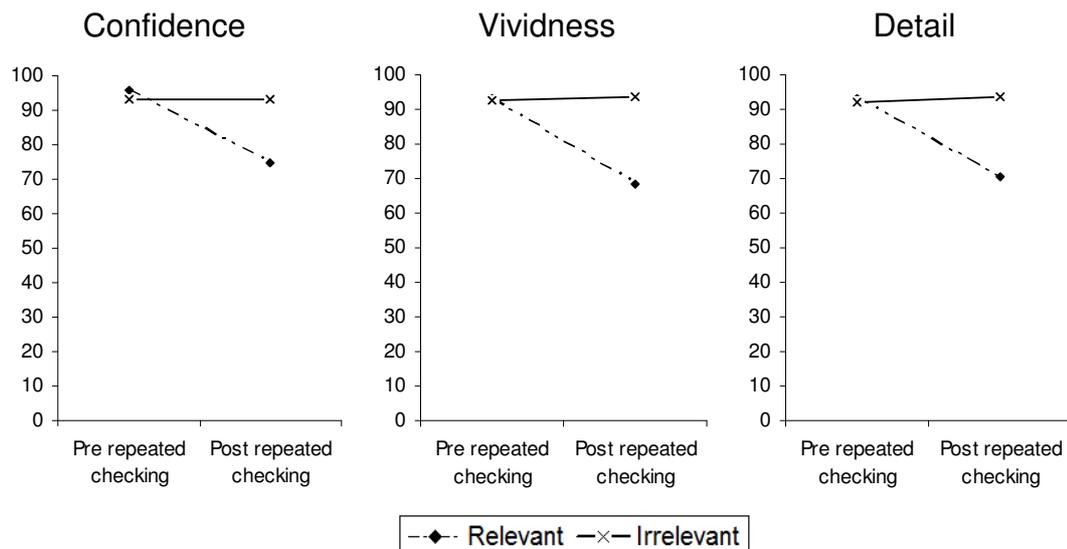


Figure 1 *Older adult sample metamemory scores across pre- and post-repeated checking*

Three separate 2 x 2 repeated measures ANOVAs were conducted on the individual dependent variables that make up meta-memory (memory confidence, vividness and detail) for the purposes of this analysis they will be reported together. The between subjects independent variable in these analyses was condition (relevant vs. irrelevant checking) while the within subjects independent variable was time (pre- vs. post-repeated checking).

Exploration of the main effects and interaction of the 2 x 2 repeated measures ANOVAs, revealed a significant main effect of time (pre- vs. post-repeated checking) on memory confidence, $F(1,18) = 22.78, p > .001 (\eta^2_p = .56)$, vividness, $F(1,18) = 17.99, p > .001 (\eta^2_p = .50)$ and detail, $F(1,18) = 20.73, p > .001 (\eta^2_p = .54)$. Overall, participants rated themselves lower on memory confidence, vividness and detail following repeated checking. There was also a significant main effect of condition (relevant vs. irrelevant checking) for vividness, $F(1,18) = 10.80, p = .004 (\eta^2_p = .38)$, and detail, $F(1,18) = 8.59, p = .009 (\eta^2_p = .32)$, but not for memory confidence, $F(1,18) = 4.00, p = .61 (\eta^2_p = .18)$. Overall, participants in the relevant

checking condition rated themselves lower on memory vividness and detail than those in the irrelevant checking condition.

Notably, there was observed to be a significant interaction between time (pre- vs. post-repeated checking) and condition (relevant vs. irrelevant checking) for memory confidence, $F(1,18) = 22.78, p > .001 (\eta^2_p = .56)$, vividness, $F(1,18) = 21.19, p > .001 (\eta^2_p = .54)$, and detail, $F(1,18) = 27.07, p > .001 (\eta^2_p = .60)$. Participants in the relevant checking condition had reduced scores in all three metamemory variables compared to those in the irrelevant checking condition following repeated checking. These results indicate that repeated checking leads to reduced memory vividness and detail as well as reduced memory confidence, replicating the findings of van den Hout & Kindt (2003a; 2003b; 2004) and Radomsky et al., (2006; 2014) within an older adults sample.

A similar analysis was undertaken to further test this effect within the MCI sample. Descriptive information regarding mean scores for the MCI sample for memory confidence vividness and detail are displayed in Table 10. As with the analysis of the older adult sample, a 2 x 2 MANOVA was not attempted and instead three separate 2 x 2 repeated measures ANOVAs were conducted on the individual dependent variables that make up meta-memory (memory confidence, vividness and detail). Figure 2 represents the interactions being investigated by these tests.

Table 10
Descriptive data for memory confidence, vividness and detail in MCI sample

	Confidence Mean (SD)	Vividness Mean (SD)	Detail Mean (SD)
Pre-repeated checking			
Relevant checking	90.00 (10.00)	95.71 (4.50)	92.86 (8.09)
Irrelevant checking	89.29 (10.97)	89.86 (7.43)	89.14 (7.08)
Post-repeated checking			
Relevant checking	66.43 (15.99)	60.00 (21.40)	65.00 (25.66)
Irrelevant checking	90.71 (12.39)	88.57 (8.52)	88.57 (8.52)

Note. MCI= Mild Cognitive Impairment. SD=Standard Deviation.

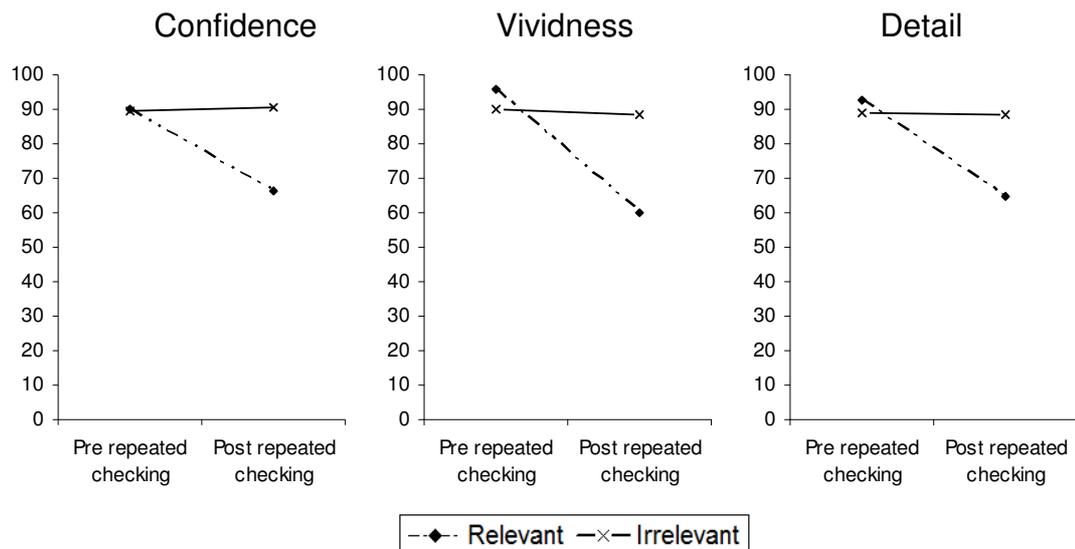


Figure 2 *MCI sample metamemory scores across pre- and post-repeated checking*

Three separate 2 x 2 repeated measures ANOVAs were conducted on the individual dependent variables for the MCI sample that make up meta-memory (memory confidence, vividness and detail) for the purposes of this analysis they will be reported together. The between subjects independent variable in these analyses was condition (relevant vs. irrelevant checking) while the within subjects independent variable was time (pre- vs. post-repeated checking). To account for multiple comparisons and reduce the chance of type I error this analysis used a Bonferroni adjustment, with a corrected p value of 0.017.

The 2 x 2 repeated measures ANOVAs failed to reveal a statistically significant effect of time for memory confidence, $F(1,12) = 7.17, p = .02 (\eta^2_p = .37)$, vividness, $F(1,12) = 6.70, p = .02 (\eta^2_p = .36)$, and detail, $F(1,12) = 6.70, p = .024 (\eta^2_p = .36)$. There was no significant main effect of condition for memory confidence, $F(1,12) = 4.98, p = .045 (\eta^2_p = .29)$, vividness $F(1,12) = 3.25, p = .096 (\eta^2_p = .29)$, or detail $F(1,12) = 3.25, p = .09 (\eta^2_p = .21)$. Given the corrected p value, a statistically significant interaction was not found for both memory vividness, $F(1,12) = 6.17, p = .03 (\eta^2_p = .29)$ and memory detail, $F(1,12) = 6.17, p = .02 (\eta^2_p = .34)$. Despite the

conservative p value used within this analysis, there was observed to be a significant interaction between time and condition for memory confidence, $F(1,12) = 9.14, p = .01$ ($\eta^2_p = .43$) indicating that participants in the relevant checking condition had reduced scores in memory confidence compared to those in the irrelevant checking condition following repeated checking.

This finding confirms that repeated checking leads to doubt in both older people and individuals with MCI, however of particular interest is whether there is a differential effect of repeated checking on memory confidence. To compare if there were differences in the ratings of memory confidence either before checking or as a result of checking between the MCI and older adult samples, both pre-checking scores and post-checking scores in the relevant checking condition were compared using independent samples t -tests. MCI and older adult samples were found not to be significantly different in ratings of memory confidence prior to repeated checking $t(32) = 1.49, p = .15$ or following repeated checking $t(15) = 1.18, p = .26$. This finding would suggest that individuals with MCI do not experience greater reductions in memory confidence as a result of repeated checking than older adults without objective memory problems.

3.5.2 Research Question 2: Does repeated relevant checking lead to significant reductions in memory accuracy in older people and people with MCI, when compared to an irrelevant checking condition?

The second research question examined whether repeated relevant checking led to significant reductions in memory accuracy compared to irrelevant checking. Figure 3 displays mean accuracy scores pre- and post-repeated checking in the older adult sample for both experimental conditions (relevant and irrelevant checking).

Figure 4 displays mean accuracy scores pre- and post-repeated checking in the MCI sample for both experimental conditions (relevant and irrelevant checking).

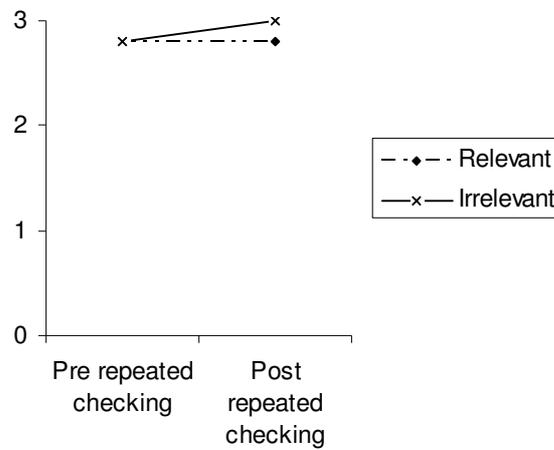


Figure 3 *Older adult sample memory accuracy scores pre- and post-repeated checking*

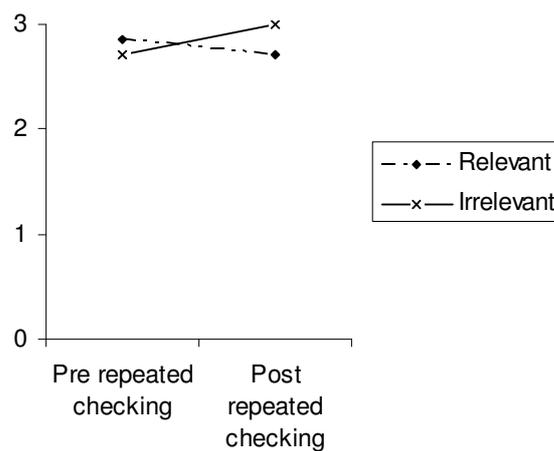


Figure 4 *MCI sample memory accuracy scores pre- and post-repeated checking*

The planned quantitative analysis of these changes using a 2 x 2 ANOVA was not attempted as assumptions for planned statistical tests were not met. Memory accuracy was high for both experimental conditions at pre- and post-checking. The data for both the older adult and MCI samples were recoded from a score out of three to correct and incorrect responses. Table 11 displays data on the number of participants both pre- and post-repeated checking in each experimental condition (relevant or irrelevant checking) who accurately remembered the corresponding

numbers of the three stove hobs checked on the last trial. Comparisons of post-repeated checking memory accuracy were made using Pearson's chi square analyses, which showed that there was no significant difference between the relevant or irrelevant checking in both the older sample, $\chi^2 = 2.22, p = .14$, and MCI sample, $\chi^2 = 2.33, p = .13$.

Table 11

	Pre-repeated checking	Post-repeated checking
Older adults sample ($n = 20$)		
Relevant checking	8 (80%)	8 (80%)
Irrelevant checking	8 (80%)	10 (10%)
MCI sample ($n = 14$)		
Relevant checking	6 (85.7%)	5 (71.4%)
Irrelevant checking	5 (71.4%)	7 (100%)

Note. n =number of participants. MCI= Mild Cognitive Impairment.

3.5.3 Research Question 3: Does repeated relevant checking result in older people and people with MCI having a general sense of “knowing” that a check has been completed rather than a specific memory of completing the check?

The third research question examined whether repeated relevant checking led to significant differences in source of memory (remembering vs. knowing) compared to irrelevant checking. Comparisons of whether participants “remember” or just “know” they performed the last check following repeated checking were made using Fisher's exact probability test. Fisher's exact probability test was chosen in place of Pearson's chi square analyses, as it was expected that the analysis would involve frequencies less than five (Field, 2013). Table 12 displays data for “remember” and “know” responses for participants both pre- and post-repeated checking in each experimental condition (relevant or irrelevant checking).

Table 12
Descriptive data on remembering vs. knowing

	Pre-repeated checking		Post-repeated checking	
	Remembering	Knowing	Remembering	Knowing
Older adults sample ($n = 20$)				
Relevant checking	10 (100%)	0 (0%)	4 (40%)	6 (60%)
Irrelevant checking	10 (100%)	0 (0%)	10 (0%)	0 (0%)
MCI sample ($n = 14$)				
Relevant checking	7 (100%)	0 (0%)	6 (85.7 %)	1 (14.3%)
Irrelevant checking	7 (100%)	0 (0%)	7 (100%)	0 (0%)

Note. n =number of participants. MCI= Mild Cognitive Impairment.

Figure 5 displays data for “remember” and “know” responses in the older adult sample post-repeated checking for both experimental conditions (relevant or irrelevant checking). There were found to be no significant differences between relevant and irrelevant checking conditions in the older adult sample pre-checking with 100% of participants in both conditions reported being able to ‘remember’ their final check. At post-checking, significantly more participants in the relevant checking condition reported just “knowing” which knobs they had checked on the final checking trial as opposed to “remembering” checking them (Fisher’s Exact Test (2-sided), $p = .01$).

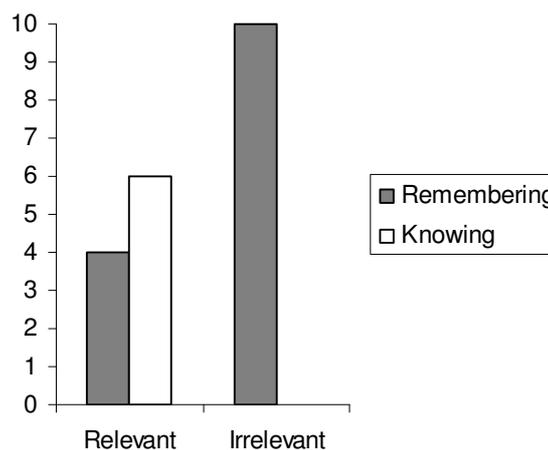


Figure 5 *Number of participants reporting “remember” vs. “know” responses in the older adult sample post-repeated checking*

Figure 6 displays data for “remember” and “know” responses in the MCI sample post-repeated checking for both experimental conditions (relevant or

irrelevant checking). To examine whether this same effect was found in the MCI sample an analysis of post-checking responses was undertaken. A similar pattern of responses was found in the MCI sample, pre-checking there were no significant differences between the relevant and irrelevant checking conditions with 100% of participants in both conditions reporting being able to “remember” their final check. However post-checking, significantly more participants in the relevant checking condition reported just “knowing” as opposed to being able to “remember” which knobs they had checked on the final checking trial (Fisher’s Exact Test (2-sided), $p = .05$).

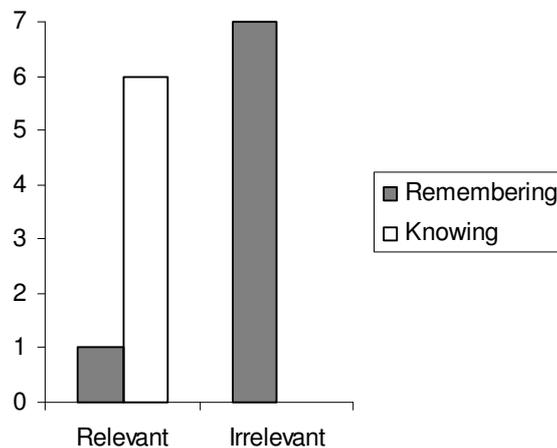


Figure 6 *Number of participants reporting “remember” vs. “know” responses in the MCI sample post-repeated checking*

3.5.4 Research Question 4: Do older people and individuals with MCI with a greater apprehension about developing Alzheimer’s disease report a higher incidence of prospective memory slips in everyday life?

The fourth research question concerned differences in reported incidences of prospective memory slips in everyday life between those who rated themselves high and those who rated themselves low in apprehension about developing dementia. There were found to be no statistically significant difference in reported prospective memory failures between the low and high apprehension groups, $U = 196.00$, $p = .051$.

4.0 Discussion

This chapter evaluates the results in relation to the research questions and in the context of the research literature. The methodology of the study is appraised, including a discussion of research design, participants, randomisation and blinding, statistical power, measures and experimental task procedure. Theoretical and clinical implications as well as directions for future research are considered.

4.1 Evaluation of Findings

4.1.1 Research Question 1

Results of the current study (see section 3.5.1) demonstrate that relevant checking lead to statistically significant reductions in metamemory (memory confidence, vividness and detail) for older people without cognitive decline. Statistically significant declines in memory confidence, vividness, and detail were found for individuals in the older adult sample from pre- to post-repeated checking as evidenced in section 3.5.1. Reductions in metamemory were found to be significantly greater for individuals in the relevant checking condition, who were asked to repeatedly check the model stove, than for those in irrelevant checking condition, who were asked to repeated check a dosette box.

The current paradigm elaborated upon an existing research protocol (Radomsky et al., 2006; 2014), adapting it for use in a naturalistic environment and introducing a novel irrelevant checking task which was more ecologically valid for use with older people. Despite changes to the stove paradigm used, findings are consistent with previous research on physical checking, including computer based stove tasks (van den Hout & Kindt, 2003a; 2003b; 2004) and laboratory based stove tasks (Radomsky et al., 2006; Radomsky et al., 2014).

In contrast to results for the relevant checking condition, there were no statistically significant declines in ratings of memory confidence, vividness and detail in the irrelevant checking condition as shown by the interaction effect (see section 3.5.1), suggesting that the effect seen in this paradigm is not related more generally to the act of checking but is specific to the repeated checking of the target object. This finding supports van den Hout and Kindt (2003b) who proposed that reductions in metamemory seen following repeated checking are the result of increased familiarity with the object being checked, rather than due to any uncertainty or anxiety inducing effect of being repeatedly required to perform checks.

Interestingly this reduction in ratings of memory vividness and detail following relevant repeated checking was not replicated in the smaller sample of individuals with MCI as no significant interaction was observed given the corrected p values for a Bonferroni adjustment (see section 3.5.1). However the small sample size means that it is important to be cautious with the interpretation of this finding and to note that both were approaching significance despite the conservative p value used within this analysis.

Statistically significant declines in memory confidence were found for individuals with MCI asked to repeatedly check the model stove, both compared to pre-test scores following only one checking trial of the stove, and compared to the irrelevant checking group who were asked to engage in repeated checking of a dosette box (see section 3.5.1). The small sample size meant that comparison of the two samples was not conducted as the main focus of the study, however this finding does provide preliminary evidence that the effects on memory confidence following repeated checking seen in non-clinical samples, similarly affect individuals with

objective memory problems. This would seem to confirm that reductions in memory confidence and perhaps vividness and detail should be considered an expected outcome following repeated checking in spite of differences in general memory confidence and ability.

4.1.2 Research Question 2

In the current study, no evidence was found for a statistically significant reduction in memory accuracy following repeated relevant checking with either the older adult or MCI samples. However it must be noted that due to limited sample size and the data not meeting required assumptions for a 2 x 2 ANOVA, more detailed statistical analysis was not attempted.

There was no statistically significant difference in post-checking memory accuracy scores for older people with and without memory decline asked to repeatedly check the model stove compared to the irrelevant checking group who were asked to engage in repeated checking of a dosette box (see section 3.5.2). The current study failed to replicate findings utilising a real stove which showed differences in memory accuracy following relevant repeated checking (Ashbaugh & Radomsky, 2007; Coles et al., 2006; Radomsky, Gilchrist, et al., 2006) but was consistent with earlier studies utilising the computerised stove task (van den Hout & Kindt; 2003a; 2003b; 2004).

Reductions in memory accuracy following repeated relevant checking remain an area of debate within the research literature (Medway & Jones, 2013; Radomsky et al., 2014). There are a number of contradictory findings, however the majority of studies that have found small but significant reductions in memory accuracy following repeated checking have utilised the functional stove paradigm (Radomsky et al., 2006; 2014). It is argued differences in findings may be related to the

ecological validity of a real stove rather than a computerised stove leading to an increase in perceived threat (Radomsky et al., 2006). However the observed differences in memory accuracy may also be explained by changes to the paradigm such as using only a single removable plastic knob to operate all six hobs which may have artificially increased the difficulty of this task. It is arguable lab-based paradigms are themselves flawed and lack ecological validity and one of the aims of this study was to conduct the experiment in a more naturalistic setting and to produce experimental stimuli that more closely approximate the real equipment.

While the current study found no statistically significant difference in memory accuracy (see section 3.5.2) between relevant and irrelevant checking for either the older adult or MCI sample, this may be at least in part related to methodology and limitations of the measure of memory accuracy (a detailed critique of the methodology is given in section 4.2). It is also possible that any impact of repeated relevant checking on memory accuracy may be more subtle than observed reductions in metamemory and that due the small sample sizes within the present study (see section 3.2), it was underpowered to detect such an effect.

4.1.3 Research Question 3

The results of the current study demonstrate that following repeated relevant checking older people report a more general sense of “knowing” that a check has been completed rather than reporting being able to “remember” a detailed specific memory of their final check. There was a statistically significant difference in post-checking ratings of source of memory between the relevant and irrelevant conditions with significantly more reporting “knowing” in the relevant checking condition (see section 3.5.3). This replicates previous findings of statistically significant difference in post-checking ratings of source of memory between the relevant and irrelevant

conditions with an adult population using both the computerised stove task (van den Hout & Kindt, 2003b; 2004) and laboratory based functional stove task (Coles et al. 2006; Radomsky et al., 2006).

Van den Hout and Kindt (2004) proposed that this change from having a specific detailed memory of the check to a more general sense of “knowing” that the check has been completed occurs due to decreased encoding of perceptual details following repeated checking. Van den Hout and Kindt (2004) argued that while responsibility and other factors may lead someone to begin checking, it was the reductions of vividness and detail of memory following repetition that produced a statistically significant change in the source of memory from visual/perceptual processing (i.e., “remembering”) to more semantic/conceptual processing (i.e., “knowing”).

As with reductions in memory confidence, the change from reporting having a specific memory of the final check of the stove to just knowing that it had been completed was replicated in the smaller sample of individuals with MCI. There was a statistically significant difference in post-checking ratings of source memory with significantly more reporting “knowing” in the relevant checking condition than in the irrelevant checking condition (see section 3.5.3). However, the small sample size requires caution in the interpretation of these findings. These findings would appear to conflict with van den Hout & Kindt’s (2004) findings as changes in memory vividness and detail post-relevant checking were found to not be statistically significant (see section 3.5.2). However as previously noted, it is important to be cautious with the interpretation of this finding and to note that both were approaching significance despite the conservative p value used within this analysis. These findings offer some support for van den Hout & Kindt’s (2004) conclusions

and indicate that, as has been shown in adult populations, older people and people with MCI switch to a more semantic source of memory in the absence of more vivid and detailed memories following repeated relevant checking.

4.1.4 Research Question 4

In the current study, no evidence was found for a statistically significant difference in reported prospective memory slips between those who rated themselves as high or low in apprehension about developing dementia (see section 3.5.4). The relationship between fear of developing a dementia and self reports of prospective memory (remembering to perform intended actions in the future) was of particular interest in relation to the current study as negative beliefs and diminished confidence in prospective memory have been shown to cause increased doubt and urges to engage in checking behaviour (Cuttler et al., 2013). Individuals with MCI have been shown to experience difficulties with prospective memory (Costa et al, 2010; Thompson et al., 2010), which was reflected in the findings as there were statistically significant differences between the MCI and older adult samples for PRMQ score and rating of fear of developing dementia (see section 3.2). This may mean that individuals with MCI may be particularly at risk of diminished confidence in prospective memory and engaging in checking.

4.2 Strengths and Limitations of the Study

4.2.1 Design

The current study utilised a between groups experimental design to test the effect of repeated checking on memory and metamemory within an older adult and an MCI sample. The use of an experimental design to test this effect provides a number of advantages notably increasing internal validity, allowing for conclusions to be reached regarding causality due to the manipulation of independent variables.

The use of a between groups design required participants to be randomised to either a relevant or irrelevant checking condition, therefore participants were not matched across condition. However analysis of these randomised groups showed that they did not differ on baseline measures or other potential confounding variable such as age or gender (see section 3.2). The use of an irrelevant checking condition as a control has been well utilised within similar paradigms (Coles et al., 2006; Radomsky et al., 2006; van den Hout & Kindt, 2004) and has advantages over a “no checking” control as groups are well matched in terms of cognitive load and both groups complete similar checking tasks.

4.2.2 Participants

This study represents the first attempt to adapt the stove paradigm to examine the effect of repeated checking in both an older adults sample and a sample of individuals with objective memory difficulties (MCI). Previous paradigms have chosen to test this experimental effect predominately in younger non-clinical, student samples (Coles et al., 2006; Radomsky et al., 2006; van den Hout & Kindt, 2004). Results from these studies report reductions in metamemory and slight reductions memory accuracy (Coles et al., 2006; Radomsky et al., 2006) following repeated checking, demonstrating that doubt following checking is not exclusively a clinical phenomenon. A number of studies have since replicated findings demonstrating that checking increases doubt rather than reducing it, within a clinical OCD population (Boschen & Vuksanovic, 2007; Radomsky et al., 2014). It is important to note that these studies did not attempt to address the idiosyncratic concerns of individuals with OCD. As with the majority of previous studies, the current study used a non-clinical population of older adults in addition to a smaller clinical sample of older people with MCI to explore basic processes and vulnerability factors. A non-clinical

sample was identified as attempting to recruit a sample of individuals with subjective memory problems would have been very difficult given the time and resources available. Although it is acknowledged that individuals presenting with subjective memory problems may potentially interpret reductions in metamemory differently to individuals without these difficulties and this is potentially something that would need to be explored in future research.

There are a number of participant factors that could potentially limit the generalisability of the findings within older adult and MCI samples. Due to the lack of a standardised approach to clinical diagnosis and diagnostic uncertainty of MCI (Smith & Bondi, 2013), it was important to have clear inclusion and exclusion criteria to establish MCI status. In this study participants entered into the MCI condition were required to have received an MCI diagnosis within the last 6 months by the referring clinician and be adjudged to score 0.5 on the CDR (Morris, 1993) as well as meeting Petersen (2011) criteria for MCI. This criteria is well established in the research literature (Stephan et al., 2013). The use of such a stringent criteria adopted in the current study, while standardising participant severity levels it nevertheless contributed to challenges with recruitment of this population. Given such it may have meant that not all clinicians would have felt confident in approaching potential participants and paradoxically may have reduced the heterogeneity of the sample in ways that are unhelpful.

The older adult sample was comprised of current and former carers of people with dementia. This group was chosen as previous research suggests such individuals may be a particularly vulnerable group, given that fear of dementia is particularly pronounced in individuals with personal experience of caring for someone with dementia (Suhr & Kinkela, 2007). This may however potentially

overestimate concerns and anxiety within the sample, limiting its generalisability more generally to the older adult population. Alternatively, it may be that people with subjective memory difficulties, who would be expected to be particularly vulnerable to the effects of repeated checking and a group of particular interest for study, differ from the wider population of non-clinical community-dwelling older people who have not attended a memory clinic for their own concerns regarding memory.

To increase the representativeness of the sample, recruitment was conducted across multiple sites and carers were recruited from both memory clinics and voluntary carer groups. However as both samples required clinicians to identify potential participants, this may potentially have led to some selection bias with clinicians being more likely to identify less “stressed” or anxious carers or individuals with MCI, however it may be that this anxiety moderates the effect of repeated checking. Within both samples potential confounding factors were accounted for, including the exclusion of individuals with presentations that may impact on memory performance and the use of baseline measures to assess potential confounders between experimental groups to include as covariates in the analysis.

4.2.3 Randomisation and Blinding

To limit the effect of potential selection bias participants were randomly allocated to each experimental condition (relevant and irrelevant checking) with the order of training phase (stove-dosette box/dosette box-stove) counterbalanced between participants. The randomisation was conducted by a UEA staff member independent of the research using random permuted blocks and held in two sets of sealed envelopes. These were held by an independent researcher who was contacted during the research assessments to reveal the allocation. This procedure ensured that

the researcher conducting the assessments was blind to allocations prior to consent being obtained which maintained the internal validity of the study.

4.2.4 Statistical Power

Power calculations were used to determine the number of participants needed to detect significant findings for memory accuracy as well as for metamemory variables. Estimates of effect size were taken from studies investigating the effect of repeated checking in non-clinical student samples. Due to challenges with recruiting samples from these populations, this sample size was not achieved in either the older adult or MCI samples. It is therefore possible that larger sample sizes may have been needed to detect significant differences in memory accuracy following repeated checking seen in other studies investigating repeated checking (Medway & Jones, 2013; Radomsky et al., 2006). It is also important to note that low power also reduces the likelihood that statistically significant results reflect a true effect (Button et al., 2013), therefore these results need to be interpreted with some caution, which is reflected in the choice of statistics and comparisons made between MCI and older adult samples.

4.2.5 Measures

This study utilised robust, reliable and valid questionnaires to measure baseline characteristics including symptoms of anxiety, depression and subjective ratings of prospective and retrospective memory failure. In addition an item was adapted from the FADS (French et al., 2012) and used to divide the sample into high and low apprehension about developing Alzheimer's disease to explore the impact of this construct. The use of a single question and likert scale response is common within studies investigated anxiety of developing dementia (French et al., 2012; Kessler et al., 2012). A single item was favoured over a more detailed measure of

this construct due to the lack of measures validated for use with individuals with MCI (French et al., 2012; Kessler et al., 2012), as well as for pragmatic reasons as currently there are no brief measures of dementia worry. The measurement of outcome variables (metamemory, memory accuracy and memory source) in this study were adapted from those used by Radomsky and colleagues (2006; 2014) in their series of experiments measuring the effects of repeated checking using a real stove within a laboratory based setting. This was important as one of the aims of the study was to attempt to replicate this paradigm within a new population using an adapted task procedure. The measure of memory accuracy commonly used within this paradigm focuses on the specific recall of which three stoves were checked on the previous trial. The use of three items was designed to increase task complexity enough to create opportunity for doubt over a simple action within a timeframe that would be acceptable for research participants, and as such only provides an approximation of the nature of checks that individuals may undertake. Despite multiple items being checked, memory accuracy is still close to ceiling and there is little variation in responses, however it is important to note that although a more complicated memory accuracy task would increase potential variation it would also reduce ecological validity. As planned data analysis using MANOVA could not be attempted, analysis of memory accuracy was instead based on the method used by van den Hout & Kindt (2003a; 2003b; 2004) who analysed the proportion of participants who accurately identified which knobs had been checked during the last checking trial rather than the number of correct responses.

The measure of metamemory variables was assessed using scales from 0 – 100 with participants being asked to rate their memory confidence, vividness and detail for their last check. These scales were relatively quick and simple for

participants to complete and therefore allowed for the measurement of multiple constructs following a single check, however there are a number of limitations to their use and it is possible the use of more detailed questionnaires to measure these constructs may provide different results. There is likely to be a ceiling effect between pre- and post-checking trials for high confidence individuals if their first rating is 100%, this means the measure while likely to capture a decrease in metamemory is unlikely to detect any further increase between checks. It is also possible to question the validity of the measures used in this paradigm, for example the measure of confidence in this experiment has been demonstrated in a number of other studies to differ from confidence in the outcome of the check (van den Hout & Kindt, 2003a; 2003b; 2004), which was not measured in this study, but has been shown to be unaffected by this paradigm. Similarly, the extent to which participants really understand the distinction between memory vividness and detail is unclear. This may explain why these variables have been shown to be highly correlated and included as part of a wider construct of metamemory rather than analysed as separate constructs in previous research (van den Hout & Kindt, 2003a; Radomsky et al., 2006). It may be given the high number of variables in this study, that participants may be more likely to repeat previous ratings when making judgements on constructs they deem as similar or related, which may mean that the order in which these measures are administered may influence participant responses.

4.2.6 Experimental Task Procedure

The task used in this study was adapted from a well established paradigm (van den Hout 2003a; Radomsky et al., 2006) used with non-clinical student populations. There is currently no evidence to suggest that there is a differential effect when tested within clinical populations (Boschen & Vuksanovic, 2007;

Radomsky et al., 2014). A particular strength of this study is the novel adapted version of the paradigm using a non-functioning model stove using knobs taken from a working stove and dosette box task. The majority of studies investigating this effect have made use of the original van den Hout and Kindt (2003a; 2003b; 2004) computerised stove task (Boschen & Vuksanovic, 2007; Medway & Jones, 2013). To improve the ecological validity of this task Radomsky, Gilchrist and Dussault, (2006) adapted the paradigm to be used in a laboratory setting using a real stove. To reduce the potential for visual checking of the stove between trials Radomsky and colleagues (2006) used a single removal knob, although acknowledged that there was no way to limit the potential for participants to engage in mental checking. However the use of a single knob somewhat paradoxically reduces the ecological validity of this task and arguably makes the task more difficult, which may explain the statistically significant reductions in memory accuracy seen within their study. The task used in present study therefore attempted to increase the ecological validity by using all 6 stove knobs. A further benefit of this method is that it is easily transportable and allows the paradigm to be tested with a harder to access population who may find transport to a university laboratory either challenging or unmanageable. The development of the model stove and dosette box was preferred to using the participants own stove and tap as this would lead to significant variation between testing materials.

Van den Hout & Kindt, (2003a) performed an intricate series of experiments to demonstrate that effects found were not due to experimental artifacts related to the testing procedure, while Medway and Jones (2013) demonstrated that the reduction in metamemory remains even following a short delay. However importantly a potential confounding variable not measured by this paradigm is performance during

both relevant and irrelevant checking trials. Although all participants complete 15 trials of relevant or irrelevant checking, attention and concentration may fluctuate and vary between different participants depending on how easy or difficult they find the checking task. If the tasks are unequal in their difficulty one group may be more bored so pay less attention, or have made mistakes so feel less confident about their performance.

The task procedure used within this study included 15 checks rather than the 20 checks used within the majority of studies testing this paradigm (van den Hout 2003a; Radomsky et al., 2006), it is possible that although significant reductions in metamemory have been demonstrated following as few as 5-10 checks (Coles et al., 2006), it remains possible that further repeated checking trials may be required to see reductions in memory accuracy. As with other experiments using a real stove (Radomsky et al., 2006; 2014) participants completion of checking trials was monitored, however care was taken by the researcher not to comment, provide verbal or visual feedback or answer questions once the experiment had begun. However to further limit the potential impact of the presence of the researcher on the participant, future research using this paradigm may wish to explore other forms of communication for instructions to be given to participants.

An important factor that needs to be considered in interpreting the findings of this study is the extent to which the paradigm represents the difficulties that may be faced by older people and individuals with MCI. It is likely that this paradigm differs from the idiosyncratic checking that may be used by individuals with memory concerns, however this is balanced against the practicalities of creating an experimental paradigm that is acceptable to research participants. This study represents an important first step to exploring the boundaries of this effect with older

people and individuals with MCI and how they may differ from non-clinical student populations. It will be important for future research to explore whether decreased memory confidence persists after a delay in older adults and particularly in individuals with MCI, as well as whether the cumulative effects of repeated checking are the same if there is an interval between checks which may be expected if repeated use of object such as calendars and dosette boxes were also to increase doubt.

4.3 Theoretical Implications of the Findings

These findings provide further support to the growing evidence base experimentally showing that repetition of checking paradoxically induces doubt and reduces confidence in memory (Radomsky et al., 2006; van den Hout & Kindt 2003a; 2003b; 2004). As well as replicating that reductions in memory confidence, vividness and detail can be achieved in fewer than the 20 checking trials originally used in van den Hout and Kindt's (2003a) computerised stove task (Coles et al., 2006; Radomsky & Alcolado; 2010). The results support the self-perpetuating mechanism proposed in Rachman's (2002) theory of compulsive checking, demonstrating the deleterious effects of repeated checking on vividness and detail as well as evidencing the change in source of memory from "remembering" to just "knowing" predicted by van den Hout & Kindt (2004). Most intriguingly, these findings expand on previous work by demonstrating reductions in metamemory following repeated checking within both an older adult and MCI sample. This has potential wider implications for research with older people where memory concerns are particularly salient and hints at a role of this effect in fear of dementia and subjective memory concerns where anxiety around potential memory failures may lead to checking which further reduces memory confidence.

In addition, the current study replicated statistically significant reductions in metamemory following repeated checking (see section 3.5.1) found in studies using the original computerised stove task (van den Hout & Kindt, 2003a; 2003b; 2004) and the laboratory based functional stove task (Coles et al., 2006; Radomsky et al., 2006), using a novel non-functional stove analogue and dosette box task. This paradigm adapted the existing research protocol (Radomsky et al., 2006; 2014), for use in a naturalistic environment which served a number of functions, notably it allowed for an analogue procedure consistent with this paradigm to be easily transported to participants' homes, which has allowed participants who otherwise would have found transport to a fixed laboratory setting too challenging to participate. A further advantage is that this has potentially increased ecological validity by allowing for the use of tasks considered more representative of checking by older people and people with memory difficulties.

However it is important to note that this study failed to find evidence to support the findings of Radomsky et al., (2006; 2014) of statistically significant reductions in memory accuracy following repeated relevant checking compared to irrelevant checking (see section 3.5.2). A potential limitation of this methodology is that because a non-functional stove is used, it does not create a real sense of threat (Radomsky et al., 2006). However given the concerns regarding memory performance that become increasingly common in older people (Jorm et al., 1994), it is hypothesised that the potential for a perceived memory failure over a seemingly simple task would provide comparable threat within an older adult or MCI population. An alternative hypothesis is that changes observed in memory accuracy may be due to the relative complexity and difficulty of the tasks used. Therefore while the study may generally be underpowered to detect this effect due to its small

sample size, it may also be due to changes in the paradigm, however further research using this paradigm is required to test this hypothesis.

4.4 Clinical Implications of the Findings

Although caution is required when interpreting the findings because of study limitations, particularly in relation to sample size and the currently unknown boundaries of the repeated checking effect. It will be important for future research to address these limitations so that differences can be understood of how repeated checking may differentially affect older adults, individuals with subjective memory problems and individuals with MCI. The findings show significant reductions in memory vividness and detail for older adults following repeated relevant checking and that even within small samples a robust effect of change in memory confidence following repeated relevant checking was found in the MCI and older adult samples (see section 3.5.1).

Given that low confidence in memory is common in older adults (Wells & Esopenko, 2008) and individuals with MCI (Frank et al., 2006) and has been shown to linked to significantly higher levels of doubt and urges to check (Cuttler et al., 2013). The current findings have some potentially important clinical implications, as they demonstrate that older people both with and without memory impairment (MCI) can experience doubt following repeated checking. Medway and Jones (2013) demonstrated in a non-clinical population that checking is not necessary for these effects to occur as repeated use without the “checking” also results in significant declines in memory accuracy, confidence, vividness and detail. This suggests that low confidence specific to frequently used objects may begin to develop before repeated checking behaviour occurs.

Taken together these findings suggest that reductions in metamemory following either checking or the use of frequently-used objects such as locking doors or turning off taps should be relatively common. This implies that key to whether an individual begins checking is likely how episodes of forgetting are interpreted. Within the current study individuals with MCI were significantly more likely to report anxiety about developing dementia than older people without impairment (see section 3.2). Anxiety about developing dementia appears to share some characteristics with the cognitive model of health anxiety (Warwick & Salkovskis, 1990), potentially leading to the development of unhelpful coping strategies such as checking and affecting their likelihood of interpreting memory lapses as evidence of dementia (Kessler et al., 2012).

The findings of this study have clear implications for the assessment and formulation of memory problems. For example there may be benefits in clinicians routinely asking questions about the use of strategies such as checking or the use of memory aids such as calendars and dosette boxes. Linked to this may be benefits to asking questions to establish if the patient experiences anxiety about developing dementia or how they interpret everyday memory mistakes such as not being able to “remember” if they shut the door. There may be simple interventions that may lessen distress in clients who experience doubt following checking including the use of psychoeducation of the problems of repeated checking and normalising these experiences or adapting the stove paradigm into a behavioural experiment to test out the usefulness of repeated checking.

4.5 Future Research

This was the first study to investigate the effects of repeated checking on memory accuracy and metamemory for older people with and without cognitive

impairment (MCI), as such further research will be required to better understand this relationship as well as providing opportunities to address the limitations of this research. Future research should attempt to address the boundaries of the repeated checking effect in relation to people with MCI and explore the external validity of this paradigm. The stove paradigm utilises a fairly complex procedure with multiple checks being completed over a short period of time to provide an approximation of an individual's experience of repeated checking (van den Hout 2003a; Radomsky et al., 2006). Coles et al. (2006) showed significant reductions in metamemory occur after as few as five to ten relevant checking trials, however as yet no studies have attempted to simplify the procedure using more ecologically valid checking items and tasks such as a dosette box or checking dates onto a calendar.

Perhaps most importantly for individuals with memory complaints will be examination of the length of time reductions in memory confidence, vividness and detail last and if there is a cumulative effect after a delay in repeated checking. Currently only one study has tested the delayed effects of repeated checking, Medway and Jones (2013) found statistically significant reductions in memory confidence, vividness and detail between relevant and irrelevant checking conditions had persisted after an 8 minutes of performing a distraction task. Finally, promising research suggests attenuation may provide a possible intervention to ameliorate the effects of familiarity resulting from repeated checking. Boschen, Wilson and Farrell (2011) found using a computerised stove task with perceptually changing stimuli, in this case stimuli which would change colour every five trials, did not lead to statistically significant differences in memory confidence, vividness and detail between relevant and irrelevant checking conditions. However for this to be applied

to a clinical population, such as individuals with cognitive impairment, this would need to be tested in more naturalistic settings using more ecological valid stimuli.

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List of Appendices

Appendix A: G-Power Screen Shot for 2X2 MANOVA

Appendix B: G-Power Screen Shot for 2X2 ANOVA

Appendix C: Stove Training Phase Diagram

Appendix D: Relevant Checking Series: Stove

Appendix E: Irrelevant Checking Series: Dosette Box

Appendix F: Clinical Demetia Rating Scale (CDR)

Appendix G: Geriatric Anxiety Inventory short form (GAI-SF)

Appendix H: 5-item Geriatric Depression Scale (5 item GDS)

Appendix I: 6-item Cognitive Impairment Test (6-CIT)

Appendix J: The Prospective and Retrospective Memory Questionnaire (PRMQ)

Appendix K: Item adapted from The Fear of Alzheimer's Disease Scale (FADS)

Appendix L: Demographic Information Sheet

Appendix M: Response Sheet: Pre-Checking

Appendix N: Response Sheet: Post-Checking

Appendix O: Ethical Approval

Appendix P: Participant Information Sheet

Appendix Q: General Practitioner Letter

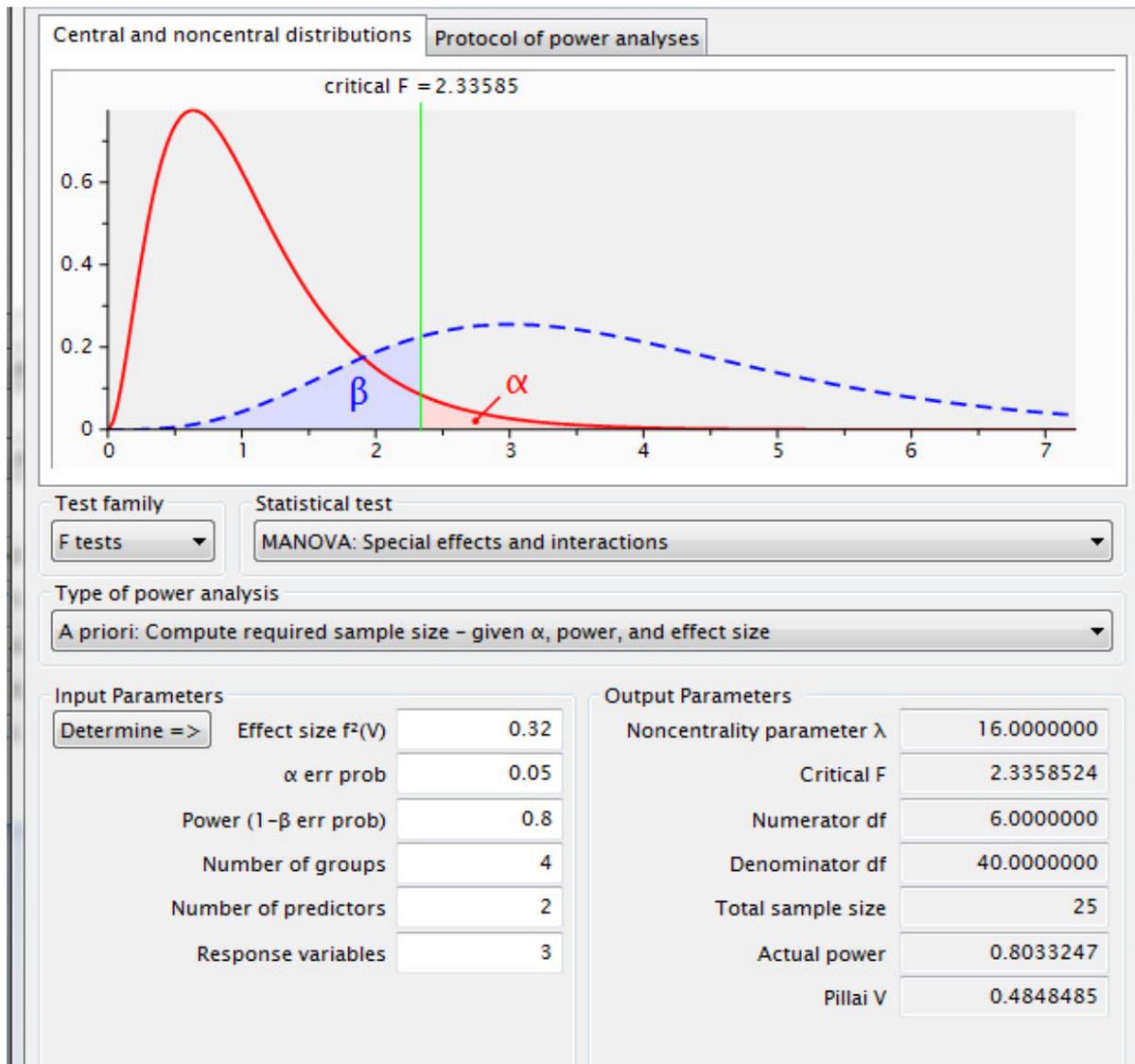
Appendix R: Consent Form

Appendix S: Follow Up Information Sheet

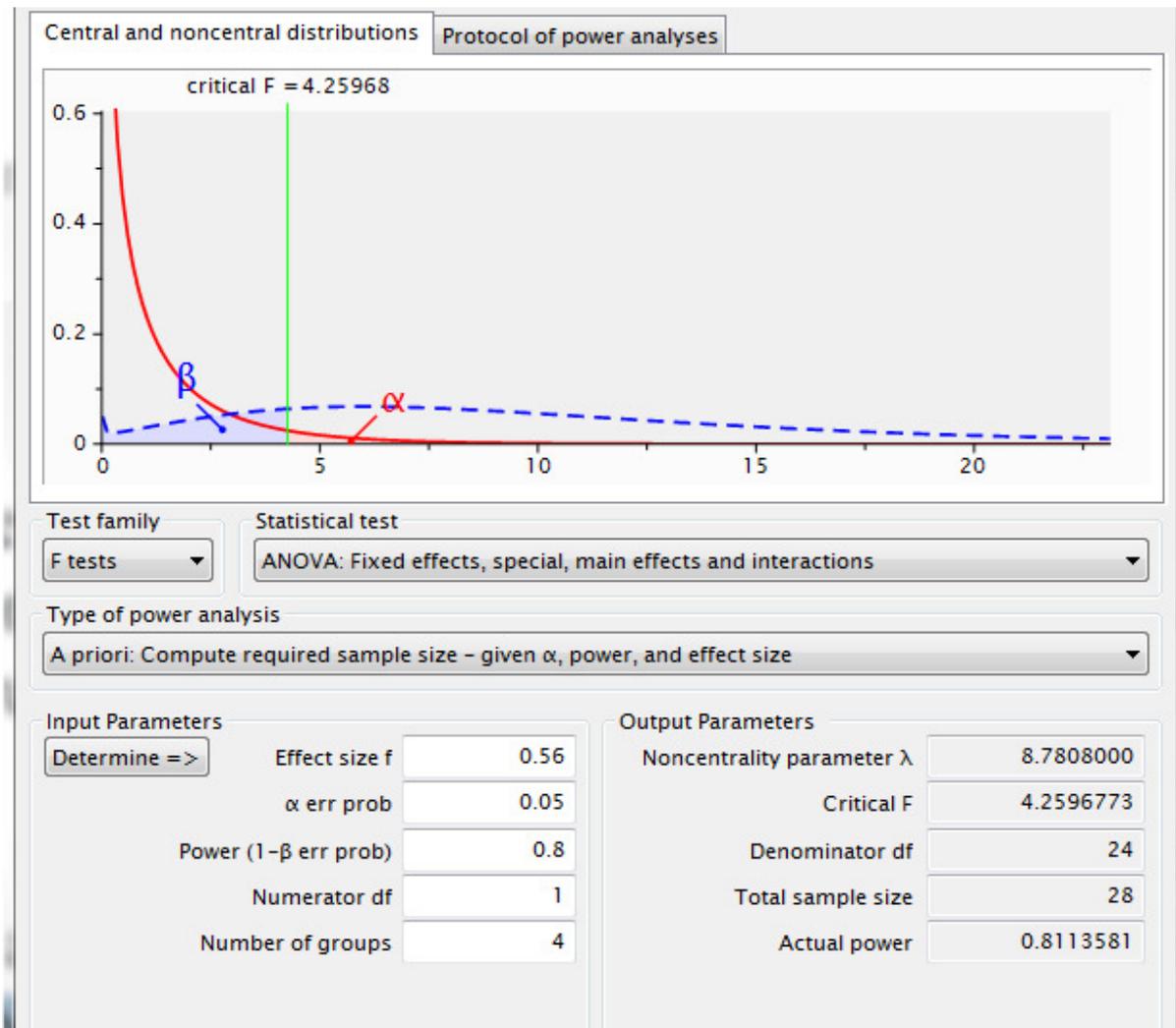
Appendix T: Telephone Script

Appendix U: Experimental Procedure Script

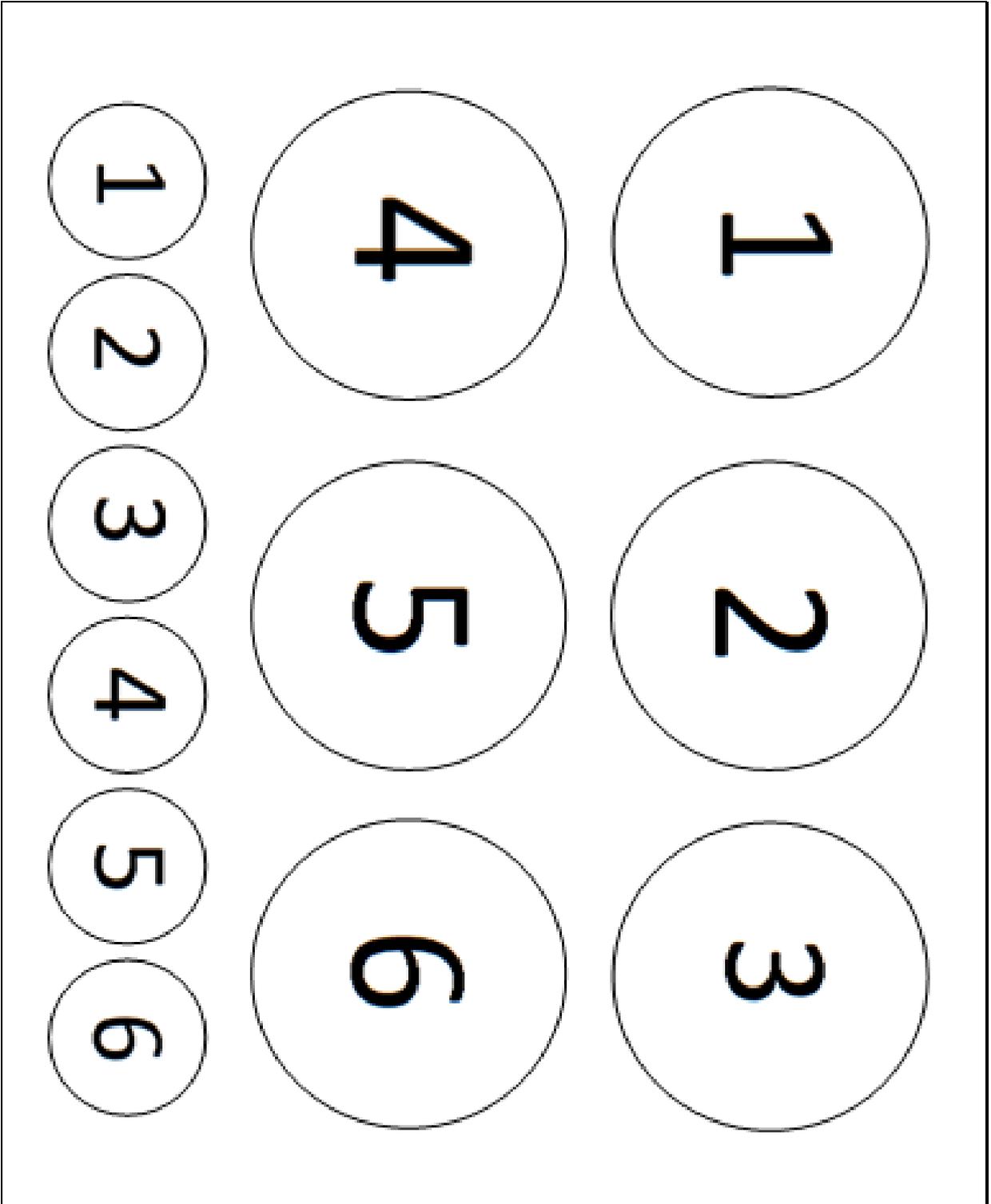
Appendix A: G-Power Screen Shot for 2x2 MANOVA



Appendix B: G-Power Screen Shot for 2x2 ANOVA



Appendix C: Stove Training Phase Diagram



Appendix D: Relevant Checking Series: Stove

PRE-TRIAL:

Please turn on burners 2, 5, 1-----Please turn them off-----Please check them.

“Now, I’m going to give you some instructions to operate and check the replica stove the way you were shown earlier”.

T1. Please turn on burners 5, 4, 6-----Please turn them off-----Please check them.

T2. Please turn on burners 3, 2, 6-----Please turn them off-----Please check them.

T3. Please turn on burners 4, 5, 2-----Please turn them off-----Please check them.

T4. Please turn on burners 3, 1, 5-----Please turn them off-----Please check them.

T5. Please turn on burners 2, 6, 4-----Please turn them off-----Please check them.

T6. Please turn on burners 4, 6, 5-----Please turn them off-----Please check them.

T7. Please turn on burners 2, 4, 1-----Please turn them off-----Please check them.

T8. Please turn on burners 2, 1, 3-----Please turn them off-----Please check them.

T9. Please turn on burners 5, 4, 1-----Please turn them off-----Please check them.

T10. Please turn on burners 2, 6, 5-----Please turn them off-----Please check them.

T11. Please turn on burners 2, 5, 1-----Please turn them off-----Please check them.

T12. Please turn on burners 4, 2, 3-----Please turn them off-----Please check them.

T13. Please turn on burners 3, 6, 1-----Please turn them off-----Please check them.

T14. Please turn on burners 6, 2, 4-----Please turn them off-----Please check them.

T15. Please turn on burners 4, 3, 6-----Please turn them off-----Please check them.

POST TRIAL:

Please turn on burners 1, 3, 6-----Please turn them off-----Please check them.

Appendix E: Irrelevant Checking Series: Dosette Box

PRE-TRIAL:

Please turn on hobs 2, 5, 1-----Please turn them off-----Please check them.

“Now, I’m going to give you some instructions to check the dosette box the way you were shown earlier.”

- T1. Please open Saturday noon-----Remove the capsule-----

Please close the lid-----Please perform the check.
- T2. Please open Tuesday morning -----Remove the capsule-----

Please close the lid-----Please perform the check.
- T3. Please open Thursday morning -----Remove the capsule-----

Please close the lid-----Please perform the check.
- T4. Please open Sunday bed -----Remove the capsule-----

Please close the lid-----Please perform the check.
- T5. Please open Wednesday noon -----Remove the capsule-----

Please close the lid-----Please perform the check.
- T6. Please open Thursday bed-----Remove the capsule-----

Please close the lid-----Please perform the check.
- T7. Please open Friday morning-----Remove the capsule-----

Please close the lid-----Please perform the check.
- T8. Please open Sunday evening-----Remove the capsule-----

Please close the lid-----Please perform the check.
- T9. Please open Monday bed-----Remove the capsule-----

Please close the lid-----Please perform the check.
- T10. Please open Tuesday evening-----Remove the capsule-----

Please close the lid-----Please perform the check.

T11. Please open Wednesday bed-----Remove the capsule-----

 Please close the lid-----Please perform the check.

T12. Please open Sunday noon-----Remove the capsule-----

 Please close the lid-----Please perform the check.

T13. Please open Friday evening-----Remove the capsule-----

 Please close the lid-----Please perform the check.

T14. Please open Tuesday noon-----Remove the capsule-----

 Please close the lid-----Please perform the check.

T15. Please open Saturday evening-----Remove the capsule-----

 Please close the lid-----Please perform the check.

“Now, I’d like you to operate the stove.”

POST TRIAL:

Please turn on hobs 1, 3, 6-----Please turn them off-----Please
 check them.

Appendix F: Clinical Dementia Rating Scale (CDR)

Participant Identification Number _____

Score the impairment when decline is due to cognitive loss not impairment from other causes:

1. Memory

0	no memory loss or slight inconsistent forgetfulness
0.5	consistent slight forgetfulness; partial recollection of events; "benign" forgetfulness
1	moderate memory loss; marked for recent events; defect interferes with everyday activities
2	severe memory loss; only highly learned material retained; new material rapidly lost
3	severe memory loss; only fragments remain

2. Orientation

0	fully orientated
0.5	fully orientated except for slight difficulty with time relationships
1	moderate difficulty with time relationships; orientated to place at examination; may have geographic disorientation elsewhere
2	severe difficulty with time relationships; usually disorientated to time, often to place
3	orientated to person only

3. Judgement and Problem Solving

0	solves everyday problems and handles business and financial affairs well; judgement good in relation to past performance
0.5	slight impairment in solving problems, similarities and differences
1	moderate difficulty in handling problems, similarities and differences; social judgement usually maintained
2	severely impaired in handling problems, similarities and differences; social judgement usually impaired
3	unable to make judgements or solve problems

4. Community Affairs

0	independent function at usual level in job, shopping and volunteer and social groups
0.5	slight impairment in these activities
1	unable to function independently in these activities although may still be engaged in some; appears normal to casual inspection
2	appears well enough to be taken to functions outside of the family home; unable to function independently outside of home
3	appears too ill to be taken to functions outside of family home; unable to function independently outside of home

5. Home and Hobbies

0	life at home, hobbies and intellectual interests well maintained
0.5	life at home, hobbies and intellectual interests slightly impaired
1	mild but definite impairment of function at home; more difficult chores abandoned; more complicated hobbies and
2	only simple chores preserved; very restricted interests, poorly sustained
3	no significant function in home outside of own room

6. Personal Care

0	fully capable of self-care
0.5	fully capable of self-care
1	needs prompting
2	requires assistance in dressing, hygiene and keeping of personal effects
3	requires much help with personal care; frequent incontinence

Assigning the Clinical Dementia Rating

There are two methods of combining the domain scores to give the overall CDR. The domain scores can either be summed to give the CDR-SB (Sum of Boxes) score, or an algorithm can be used as follows:

The global CDR score is derived from the scores in each of the six categories. Memory (M) is considered the primary category and all others are secondary. CDR = M if at least three secondary categories are given the same score as memory. Whenever three or more secondary categories are given a score greater or less than the memory score, CDR equals the score of the majority of secondary categories that are on whichever side of M has the greatest number of secondary categories. If there are ties in the secondary categories on one side of M, the CDR score closest to M is chosen.

When M = 0.5, CDR = 1 if at least three of the other categories are scored one or greater.

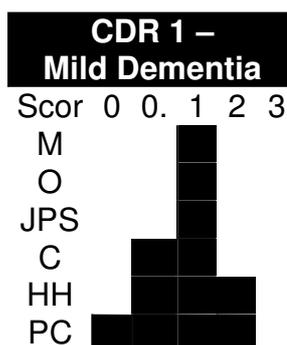
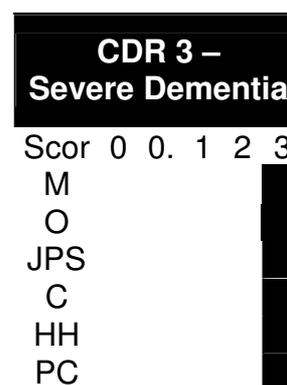
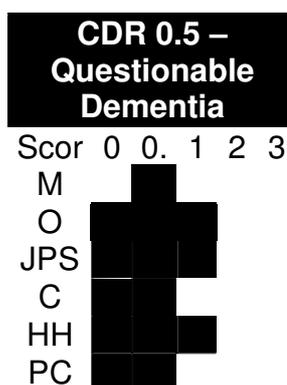
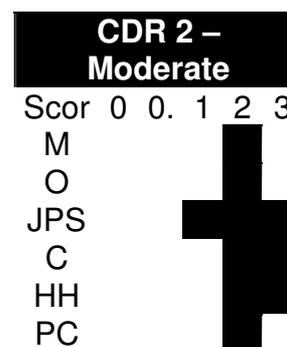
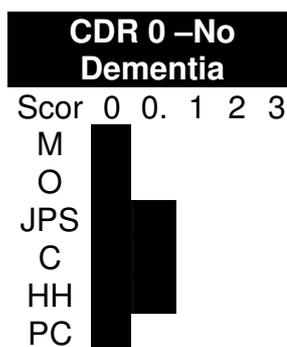
If M = 0.5, CDR cannot be 0; it can only be 0.5 or 1. If M = 0, CDR = 0 unless there is questionable impairment in two or more secondary categories, in which case CDR = 0.5.

Score	0	0.5	1	2	3
M					
O					
JPS					
C					
HH					
PC					

Mark in only one box for each category. To assign the CDR, see grids on the right. Shaded areas indicate defined range within which the scores of individual subjects must fall to be assigned a given

Clinical Dementia Rating (circle)

0	0.5	1	2	3
---	-----	---	---	---



Appendix G: Geriatric Anxiety Inventory short form (GAI-SF)

Participant Identification Number _____

Please read the following questions.

Please circle your response for each question.

1	I worry a lot of the time	AGREE	DISAGREE	
2	Little things bother me a lot	AGREE	DISAGREE	
3	I think of myself as a worrier	AGREE	DISAGREE	
4	I often feel nervous	AGREE	DISAGREE	
5	My own thoughts often make me nervous	AGREE	DISAGREE	

Appendix H: 5-item Geriatric Depression Scale (5 item GDS)

Participant Identification Number _____

Please read the following questions.

Write down your answers.

To each question answer YES or NO.

		YES or NO
1	Are you basically satisfied with your life?	
2	Do you often get bored?	
3	Do you often feel hopeless?	
4	Do you prefer to stay at home rather than going out a doing new things?	
5	Do you feel pretty worthless the way you are now?	

'No' in Q1 and 'yes' in Q2-5 score 1.

Appendix I: 6-item Cognitive Impairment Test (6-CIT)

Participant Identification Number _____

1. What year is it?	Correct - 0 points Incorrect - 4 points
2. What month is it?	Correct - 0 points Incorrect - 3 points
3. Give the patient an address phrase to remember with 5 components, e.g. <i>John, Smith, 42, High St, Bedford</i>	
4. About what time is it (within 1 hour)	Correct - 0 points Incorrect - 3 points
5. Count backwards from 20-1	Correct - 0 points 1 error - 2 points More than one error - 4 points
6. Say the months of the year in reverse	Correct - 0 points 1 error - 2 points More than one error - 4 points
7. Repeat address phrase	Correct - 0 points 1 error - 2 points 2 errors - 4 points 3 errors - 6 points 4 errors - 8 points All wrong - 10 points
6-CIT Total score: /28	

Appendix J: The Prospective and Retrospective Memory Questionnaire (PRMQ)

Participant Identification Number _____

In order to understand why people make memory mistakes, we need to find out about the kinds of mistakes people make, and how often they are made in normal everyday life. We would like you to tell us how often these kinds of things happen to you.

Please indicate by ticking the appropriate box.

Please make sure you answer all of the questions on both sides of the sheet even if they don't seem entirely applicable to your situation.

Please answer all of the questions as accurately as possible

	Very Often	Quite Often	Sometimes	Rarely	Never
Do you decide to do something in a few minutes' time and then forget to do it?					
Do you fail to recognise a place you have visited before?					
Do you fail to do something you were supposed to do a few minutes later even though it's there in front of you, like take a pill or turn off the kettle?					
Do you forget something that you were told a few minutes before?					
Do you forget appointments if you are not prompted by someone else or by a reminder such as a calendar or diary?					

Participant Identification Number _____

	Very Often	Quite Often	Sometimes	Rarely	Never
Do you fail to recognise a character in a radio or television show from scene to scene?					
Do you forget to buy something you planned to buy, like a birthday card, even when you see the shop?					
Do you fail to recall things that have happened to you in the last few days?					
Do you repeat the same story to the same person on different occasions?					
Do you intend to take something with you, before leaving a room or going out, but minutes later leave it behind, even though it's there in front of you?					
Do you mislay something that you have just put down, like a magazine or glasses?					
Do you fail to mention or give something to a visitor that you were asked to pass on?					
Do you look at something without realising you have seen it moments before?					
If you tried to contact a friend or relative who was out, would you forget to try again later?					
Do you forget what you watched on television the previous day?					
Do you forget to tell someone something you had meant to mention a few minutes ago?					

Appendix K: Item adapted from The Fear of Alzheimer's Disease Scale (FADS)

Participant Identification Number _____

Please rate the extent to which you would agree with the statement below. Indicate your answer by circling the appropriate box.

I think that I will probably get Alzheimer's disease, and it frightens me.Strongly
Disagree

Disagree

Agree

Strongly
Agree

Appendix L: Demographic Information Sheet

Participant Identification Number _____

Age: _____ years

Gender: M F

Ethnicity: _____

Marital Status: _____

Highest qualification achieved: _____

Current/previous occupation: _____

Thinking about both the good and bad things that make up your life, how would you rate your quality of life as a whole?

Poor Fair Good Excellent

How would you rate your physical health?

Poor Fair Good Excellent

Current Medications:

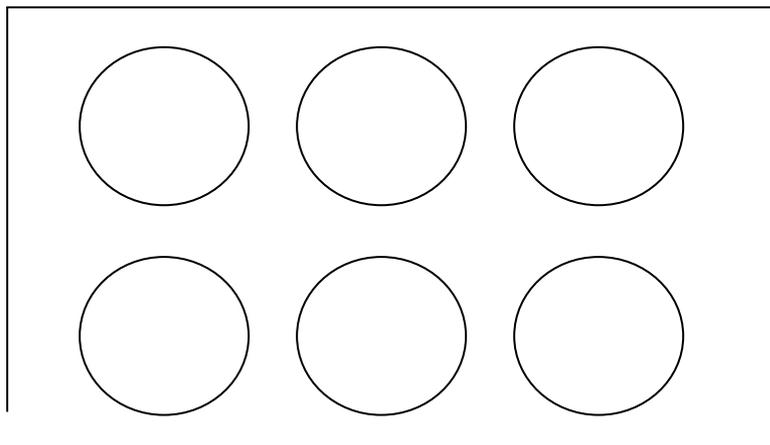
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Appendix M: Response Sheet: Pre-Checking

Participant Identification Number _____

1. Which three knobs did you check on the last trial, and in which order?

(Please indicate your answer on the following diagram by marking an “1” for first item checked, a “2” for second item checked, and a “3” for third item checked in the appropriate spots).



2. On a scale of 0-100 where 0 means “not at all” and 100 means “extremely”, how would you rate:

- Your confidence in your answers to question 1 overall? _____
- The vividness (e.g. clarity, intensity) of your memory of the last checking trial: _____
- The detail (e.g. particular visual features) in your memory of your last checking trial: _____

3. Please read the following:

“**Knowing**” the knobs are all off means that you have a general sense that they are off. Even if you do not have a concrete detailed memory, you just know they are turned off. For example, your memory of tying your shoes this morning is probably “known” as opposed to “remembered”.

“**Remembering**” the knobs are turned off means you can go through your memory and bring up the detailed process (with specific features) of turning them off. For example, your memory of meeting me for the first time today is probably “remembered” as opposed to just “known.”

Once the above distinction is clear, please answer the following:

Think about the last trial and indicate by circling below which kind of memory best applies.

“remembering”

“knowing”

Appendix N: Response Sheet: Post-Checking

Participant Identification Number _____

1. Which three knobs did you check on the last trial, and in which order?

(Please indicate your answer on the following diagram by marking an "1" for first item checked, a "2" for second item checked, and a "3" for third item checked in the appropriate spots).

2. On a scale of 0-100 where 0 means "not at all" and 100 means "extremely", how would you rate:

- Your confidence in your answers to question 1 overall? _____
- The vividness (e.g. clarity, intensity) of your memory of the last checking trial: _____
- The detail (e.g. particular visual features) in your memory of your last checking trial: _____

3. Please read the following:

"Knowing" the knobs are all off means that you have a general sense that they are off. Even if you do not have a concrete detailed memory, you just know they are turned off. For example, your memory of tying your shoes this morning is probably "known" as opposed to "remembered".

"Remembering" the knobs are turned off means you can go through your memory and bring up the detailed process (with specific features) of turning them off. For example, your memory of meeting me for the first time today is probably "remembered" as opposed to just "known."

Once the above distinction is clear, please answer the following:

Think about the last trial and indicate by circling below which kind of memory best applies.

"remembering"

"knowing"

Appendix O: Ethical approval



Health Research Authority

NRES Committee East of England - Essex

The Old Chapel
Royal Standard Place
Nottingham
NG1 6FS

Telephone: 0115 883 9695

19 June 2015

Mr Miles Lattimer

Department of Clinical Psychology, Norwich Medical School, Faculty of Medicine and Health Sciences,

University of East Anglia, Norwich Research Park,

Norwich

NR4 7TJ

Dear Mr Lattimer

Study title:	The Impact of repeated checking on memory accuracy and meta-memory in individuals with mild cognitive impairment (MCI)
REC reference:	15/EE/0174
IRAS project ID:	170456

Thank you for your submission of 12 June 2015, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this favourable opinion letter. The expectation is that this information will be published for all studies that receive an ethical opinion but should you wish to provide a substitute contact point, wish to make a request to defer, or require further information, please contact the REC Manager, Mrs Helen Poole, NRESCommittee.EastofEngland-Essex@nhs.net. Under very limited circumstances (e.g. for student research which has received an unfavourable opinion), it may be possible to grant an exemption to the publication of the study.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at <http://www.rdforum.nhs.uk>.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database. This should be before the first participant is recruited but no later than 6 weeks after recruitment of the first participant.

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to request a deferral for study registration within the required timeframe, they should contact hra.studyregistration@nhs.net. The expectation is that all clinical trials will be registered, however, in exceptional circumstances non registration may be permissible with prior agreement from NRES. Guidance on where to register is provided on the HRA website.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see

"Conditions of the favourable opinion" below).

Non-NHS sites

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Evidence of Sponsor Insurance or Indemnity (non NHS Sponsors only) [Insurance and Indemnity Letter]		08 April 2015
GP/consultant Information sheets or letters [GP Letter]	v1.0	04 February 2015
Letter from sponsor [Insurance and Indemnity Letter]		08 April 2015
Other [Research CV (second academic supervisor) - Adrian Leddy]		04 February 2015
Other [Questionnaire Pack]	v1.0	04 February 2015
Other [Task Instructions: relevant/irrelevant checking]	v1.0	16 April 2015
Other [Participant Debriefing Sheet]	v1.1	12 June 2015
Other [Telephone Script]	v1.0	12 June 2015
Other [Experimental Procedure Script]	v1.0	12 June 2015
Other [Review process]		22 May 2015
Other [Amendments cover letter 12/06/15]		12 June 2015
Participant consent form [Participant Consent Form]	v1.0	04 February 2015
Participant information sheet (PIS) [Participant Information Sheet]	v1.2	12 June 2015
REC Application Form [REC_Form_08042015]		08 April 2015
Referee's report or other scientific critique report [Peer review: UEA Thesis Proposal Feedback]		16 April 2015
Research protocol or project proposal [Thesis Proposal]	v1.2	12 June 2015
Summary CV for Chief Investigator (CI) [Research CV (CI) - Miles Lattimer]		04 February 2015
Summary CV for supervisor (student research) [Research CV (academic supervisor) - Kenneth Laidlaw]		04 February 2015

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol

- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:

<http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/>

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at

<http://www.hra.nhs.uk/hra-training/>

15/EE/0174	Please quote this number on all correspondence
------------	------------------------------------------------

With the Committee's best wishes for the success of this project.

Yours sincerely



PP

Dr Alan Lamont
Chair

Email: NRESCommittee.EastofEngland-Essex@nhs.net

Enclosures: "After ethical review – guidance for researchers"

Copy to: Mrs Sue Steel
Dr Bonnie Teague, Norfolk & Suffolk NHS Foundation Trust

Appendix P: Participant Information Sheet

The effects of repeated checking on memory

Invitation to participate in a research study

You are being invited to take part in a research study which is being conducted as part of my Doctorate in Clinical Psychology. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take some time to read the following information carefully and do not hesitate to ask questions if there is anything that is not clear or if you would like more information. Thank you for reading this information sheet.

What is the purpose of the study?

The study will aim to investigate whether checking is a helpful or unhelpful strategy for people both with and without memory concerns. Many people with memory concerns engage in checking in an attempt to remove doubt about completion of tasks, or to remove uncertainty because of concerns about memory performance. However recent research has suggested checking may in fact lead to increased doubt. This may be particularly important for individuals with memory difficulties where increased doubt may undermine confidence in their abilities. We will therefore be looking to compare the impact of checking memory in people both with and without memory difficulties. The results of the study will hopefully help us to better advise those with memory difficulties on the benefits or problems of checking as a strategy to aid memory.

Who is being invited to take part?

We hope to recruit people with and without memory concerns/difficulties to help us understand the impact of memory checking. If you agree to take part in our study we will assign you to the appropriate group, in this way we will be able to compare the differences between the groups. The first group will be adults who experience some difficulties with their memory and have a diagnosis of mild cognitive impairment (MCI). The second group will be individuals over 60 years old who do not currently experience difficulties with memory. Participants must also be able to complete some tasks as part of the study and be able to answer questions in English.

Do I have to take part?

Participation is voluntary and it is completely up to you to choose whether or not to take part. If after reading this information sheet, you do decide to take part, you will be asked to sign a consent form to show that you are happy to participate in the study. If you decide to take part you are still free to withdraw at any time without giving a reason. A decision to not take part or to withdraw will not affect the standard of care you receive within the NHS.

What will happen to me if I take part?

If you agree to take part in the study, a researcher will meet with you either at your home or an alternative location, if you would prefer. Following discussion of any questions you may have and completion of the consent form, you will be instructed on how to operate a non functioning replica stove and how to check a dosette box. You will then be asked to perform a series of checking tasks. Following this, you will be asked some questions and complete a small package of questionnaires relating to your memory and mood. In total, this will take approximately 1 hour to complete.

Will my taking part in the study be kept confidential?

We will ask for your permission to send your GP a letter explaining that you have agreed to take part in the study. All information that is collected about you during the

course of the study will be kept confidential and will only be seen by members of the research team. However if you were to disclose information that may result in either you or anyone else being put at risk of harm, there may be a need to break this confidentiality and inform individuals involved in your care (either the professional who referred you to the study or your GP).

All data is stored without any identifying details under secure conditions. All paper copies of the questionnaire booklets will be kept in a locked drawer and any information that we enter on a computer will be password protected. Once the study is completed, all of the information will be stored in a locked drawer at the University of East Anglia for 10 years, in line with UEA Research Data Management Policy, after which it will be securely destroyed.

What will happen to the results?

The information collected will be reported in my doctoral thesis, which will possibly be edited for publication in an academic journal. No participants will be identified in any publication arising from the study.

What are the possible disadvantages or risks of taking part?

Previous research suggests checking can increase doubt for whether or not an action has been completed, therefore some uncertainty in memory is normal and would be expected during these activities. You will also be asked some questions about memory, which some people can find difficult to talk about when they are experiencing a problem with their memory. Although this is not expected, if you do feel distressed at any point during the study, you can withdraw from it without having to give a reason. If you do feel distressed during or after the research, you can discuss this with me or my supervisor. Alternatively, you may wish to contact your local General Practitioner (GP).

What are the possible benefits of taking part?

Although there are no direct benefits to taking part in the study, its results will hopefully improve our understanding of the use of checking as a strategy for those with memory concerns and help us to better advise individuals who experience difficulties with memory.

Complaints

If you are unhappy about any aspect of your participation, we will do our best to resolve any concerns you may have. However if you remain dissatisfied and wish to make a complaint about the way you have been approached or treated during the course of this study, the normal National Health Service complaints procedures are available to you by contacting the Patients' Advice and Liaison Service (PALS).

Patients' Advice and Liaison Service (PALS).

Norfolk and Suffolk NHS Foundation Trust, Hellesdon Hospital, Drayton High Road, Norwich, Norfolk, NR6 5BE

Telephone: 0800 279 7257

Email: PALS@nsft.nhs.uk

Who has reviewed the study?

All NHS research is looked at by an independent group, called a Research Ethics Committee, to protect your safety, rights, well-being and dignity. This study has been reviewed and been given a favourable opinion by (reviewing body will be inserted once confirmed) Research Ethics Committee.

Further information and contact details

If you have any further queries about the study or if you are interested in being informed of the study findings, then please contact either myself or my supervisor using the contact details below:

Miles Lattimer (Trainee Clinical Psychologist)

Department of Clinical Psychology,
Norwich Medical School,
Faculty of Medicine and Health Sciences,
University of East Anglia,
Norwich Research Park;
Norwich, NR4 7TJ.

E-mail: M.Lattimer@uea.ac.uk

Telephone: 07561 346 673

Faculty of Medicine and Health Sciences,
University of East Anglia,
Norwich Research Park;
Norwich, NR4 7TJ.

E-mail: K.Laidlaw@uea.ac.uk

gy/Programme Director

Thank you for considering taking part in this research study!

Appendix Q: General Practitioner Letter

< GP Address >
< Date >

Miles Lattimer
Department of Clinical Psychology,
Norwich Medical School,
Faculty of Medicine and Health Sciences,
University of East Anglia,
Norwich Research Park;
Norwich, NR4 7TJ

The effects of repeated checking on memory

Email: M.Lattimer@uea.ac.uk

NAME (DOB:) has been invited and consented to take part in a research study. Please let us know if there is anything that is not clear, or if you would like more information.

This project is run by Miles Lattimer who is a Trainee Clinical Psychologist based at University East Anglia (UEA) as part of the Doctorate in Clinical Psychology.

The purpose of the study is to investigate the influence of checking behaviour on individuals both with and without Mild Cognitive Impairment (MCI). Many people engage in checking in an attempt to feel certain, however previous research has suggested that checking can lead to increased doubt. Further research is needed to see whether this is the case for people with memory problems, where increased doubt may further undermine confidence in their abilities. The study will therefore aim to explore whether repeated checking is a helpful or unhelpful strategy for people both with and without memory difficulties.

Participants were asked to perform a series of checking tasks involving a non functioning replica stove and a dosette box. Following this, they were asked some questions and completed a small package of questionnaires relating to memory, cognition and mood. In total, this took approximately 1 hour to complete.

The information collected will be reported in my doctoral thesis, which will possibly be edited for publication in an academic journal. The information collected in the study will be anonymous and patients will not be identified in any publication arising from the study.

Participation in this study will not affect the patient's standard of current or future treatment.

This study has been reviewed and been given a favourable opinion by the NRES East of England – Essex Research Ethics Committee.

Thank you for reading this information sheet. Please do not hesitate to contact me if you need any further information.

Kind regards,

Miles Lattimer
Trainee Clinical Psychologist

Appendix R: Consent Form

Participant Identification Number for this trial _____

Name of Researcher: _____

The effects of repeated checking on memory

Please put your initials in the boxes below if you agree with the following statements

1. I confirm that I have read the information sheet (Version X) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

(Please put your initials in the box, if you agree.)

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

(Please put your initials in the box, if you agree.)

3. I give permission for my GP to be informed of my participation in the study.

(Please put your initials in the box, if you agree.)

4. I understand that all information given by me or about me will be treated as confidential by the research team.

(Please put your initials in the box, if you agree.)

5. I agree to take part in the study.

(Please put your initials in the box, if you agree.)

Name of participant

Date

Signature

Name of person taking consent

Date

Signature

Appendix S: Follow Up Information Sheet

Thank you for participating in this study.

This study was designed to look at memory confidence in individuals both with and without Mild Cognitive Impairment (MCI). Previous research (using undergraduate students who were asked to check a stove) suggests that repeated checking of the same thing over and over again, will lead to reduced confidence in that particular memory as well as lower detail and vividness, while memory accuracy does not seem to be affected. In this experiment, we had some participants repeatedly check a replica stove while others were asked to check a dosette box or pill organiser. Following this, both groups were asked to check the replica stove for one trial.

Our prediction is that the group who were asked to check the replica stove many times will report lower confidence in their memory for the final check of the stove than the group who were asked to repeatedly check the dosette box. We are also expecting the group who repeatedly checked the stove to rely more on “knowing” that they performed the check rather than being able to “remember”.

It is our hope that your help will enable us to develop better memory aids and to better advise individuals who have been diagnosed with MCI or who experience difficulties with memory. It is important to note that many people experience different levels of confidence and memory for a variety of things and that many participants have difficulty remembering the specific details of this task.

If you would like further information, have any questions or concerns about the study, or if you are interested in being informed of the study findings, then please contact either myself or my supervisor:

Miles Lattimer (Trainee Clinical Psychologist)

School of Medicine, Health Policy, and Practice. UEA, Norwich, NR4 7TJ.

E-mail: M.Lattimer@uea.ac.uk

Prof. Ken Laidlaw (Professor of Clinical Psychology/Programme Director ClinPsyD)

School of Medicine, Health Policy, and Practice. UEA, Norwich, NR4 7TJ.

E-mail: K.Laidlaw@uea.ac.uk

Appendix T: Telephone Script
The effects of repeated checking on memory

Script 1: Interest in Participating

“Hello Mrs/Mr/Ms _____ (Participant Name)

My name is _____ (Researcher Name), I’m calling with regard to the Effects of Repeated Checking on Memory research study. I understand from _____ (Clinician Name) that you’re interested in receiving more information about the research study?”

(If the person does not recognise the research study, briefly remind them about the study, (see ‘Yes’ below) and how they provided their contact details, health professional they spoke to etc)

YES



NO

“Good. The purpose of the study is to investigate whether repeated checking is a helpful or unhelpful strategy for people who experience some difficulties with memory. Many people check in an attempt to feel certain, although previous research has suggested that checking can increase doubt. We want to look at whether this is the case for people with memory problems. To do this we will be comparing people both with and without memory difficulties. What I can do is send you a Participant Information Sheet in the post, give you some time to read it over and then I can phone you a few days after that to answer any questions you might h

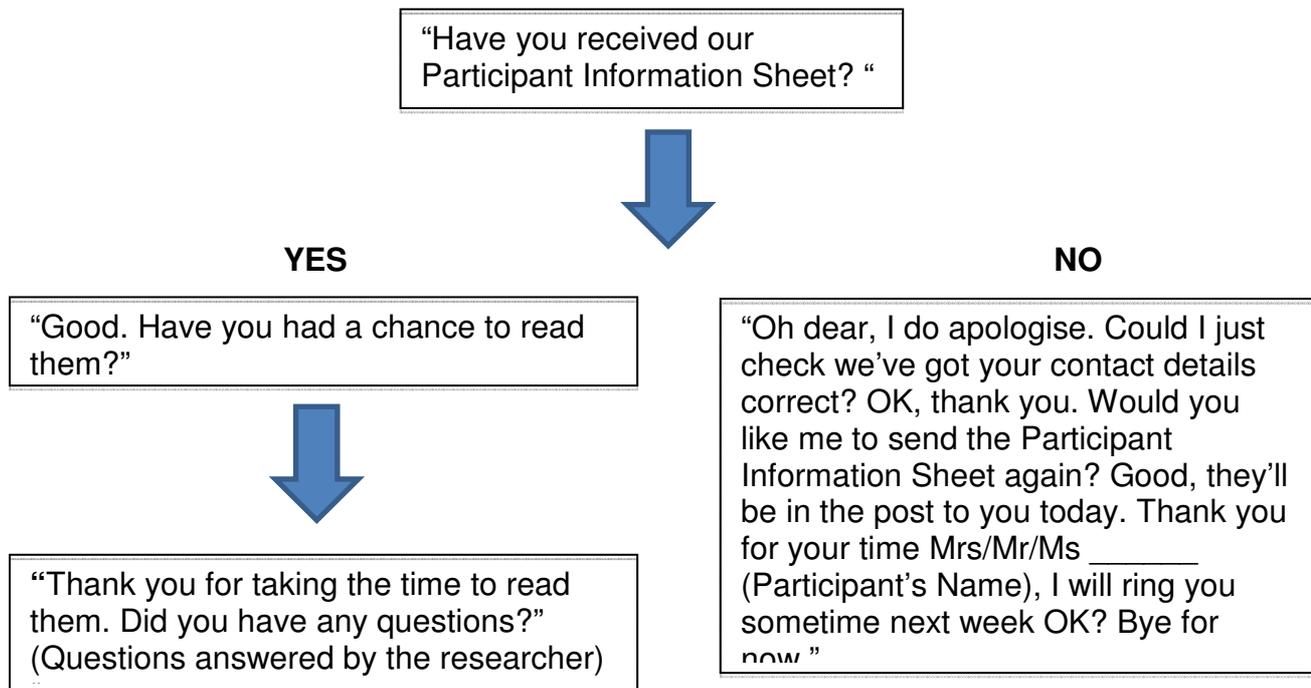
“That’s no problem, thank you for your

Script 2: Appointment booking

“Hello Mrs/Mr/Ms _____ (Participant Name)

My name is _____ (Researcher Name), I’m calling with regard to the Effects of Repeated Checking on Memory research study. I phoned you _____ (Time period, e.g. last week).

(If the person does not recognise the researcher or recall any phone call, briefly run through contact with them so far)



Questions about the following topics should be answered using the wording below.

Do I have to take part?

Participation is voluntary and it is completely up to you to choose whether or not to take part. If you do decide to take part, you will be asked to sign a consent form to show that you are happy to participate in the study. You are free to withdraw at any time without giving a reason and a decision to withdraw or not to take part, will not affect the standard of care you receive within the NHS.

What will happen to me if I take part?

If you agree to take part in the study, I will meet with you either at your home or an alternative location, if you would prefer. Following discussion of any questions you may have and completion of the consent form, you will be asked to perform a series of checking tasks using a non functioning replica stove and a dosette box. You will be then be asked some questions and complete a small package of questionnaires relating to your memory and mood. In total, this will take approximately 1 hour to complete.

Will my taking part in the study be kept confidential?

I will ask for your permission to send your GP a letter explaining that you have agreed to take part in the study. All information that is collected about you during the course of the study will be kept confidential, unless I was concerned that you might be at risk of harming yourself or other people, then I would need to break this confidentiality and talk to someone involved in your care, either a health worker at your service or your GP, to inform them of this. I would try to discuss this with you first if that did happen.

What will happen to the results?

All data is stored without any identifying details under secure conditions. The paper copies of the questionnaire booklets will be kept in a locked drawer and any information that we enter on a computer will be password protected. Once the study is completed, all of the information will be stored in a locked drawer at the University of East Anglia for 10 years, in line with UEA Research Data Management Policy, after which it will be securely destroyed.

The information collected will be reported in my doctoral thesis, which will possibly be edited for publication in an academic journal. You would not be identifiable in any publication arising from the study.

Who has reviewed the study?

All NHS research is looked at by an independent group, called a Research Ethics Committee, to protect your safety, rights, well-being and dignity. This study has been reviewed and been given a favourable opinion by the NRES East of England – Essex Research Ethics Committee.

What are the possible disadvantages or risks of taking part?

Previous research suggests checking can increase doubt for whether or not an action has been completed, therefore some uncertainty in memory is normal and would be expected during these activities. You will also be asked some questions about memory, which some people can find difficult to talk about when they are experiencing a problem with their memory. Although this is not expected, if you do feel distressed at any point during the study, you can withdraw from it without having to give a reason. If you do feel distressed during or after the research, you can discuss this with me or my supervisor. Alternatively, you may wish to contact your local General Practitioner (GP).

What are the possible benefits of taking part?

Although there are no direct benefits to taking part in the study, its results will hopefully improve our understanding of mild cognitive impairment and help us to better advise individuals who experience difficulties with their memory.

YES

NO



“Good. What I’d like to do now is to arrange a convenient date and time to visit you.”

“At the visit, if you are still happy to participate and following completion of a consent form, you will be asked to perform a series of checking tasks involving a non functioning replica stove and a dosette box. You will then be asked some questions relating to your memory and mood. It should take around 1 hour to complete. Is that all OK?”

“Great, would you prefer to meet at your home or at an alternative location? The experiment requires a quiet area with no distractions and a flat surface such as a table on which to place the stimuli.”

“Okay, would any of these dates/times be convenient for you?”

“Good. I look forward to seeing you then.”

“That’s no problem, thank you for your time.”

Appendix U: Experimental Procedure Script

The effects of repeated checking on memory

*****These instructions should be given following the signing of the consent form and the call to determine randomised assignment for STOVE/DOSETTE BOX order in the training phase, as well as RELEVANT or IRRELEVANT checking conditions*****

“First I will show you how to operate and check the stove and the dosette box after which I will ask you to complete a series of these operations. Following this, you will be asked some questions and asked to complete some questionnaires. As we discussed, you have the right to withdraw from participating at any time, without any negative consequences. Any questions?”

“Before we start I’d like to emphasise that there are a lot of operations to go through, but no “tricks” or “surprises” are involved. Alright, let’s begin.”

TRAINING PHASE:

*****STOVE/DOSETTE BOX order determined by randomised assignment*****

(STOVE)

****Introduce stove stimulus****

“These are the six knobs that you will be operating that correspond to the 6 stove tops. **(pointing at the relevant knobs and stove tops)** We will refer to them as numbers 1, 2, 3, 4, 5 and 6. You will be operating knobs in sets of threes at any given time. For example, if I asked you to turn burners 1, 3 and 2 on, you would turn the corresponding knobs from the off mark a quarter turn to the right (where the knob will point to the “3” on a standard clock), like this **(demonstration)**. When asked to turn them off, you simply turn them counter-clockwise back to the off-mark **(demonstration)**. When asked to check them, you should wiggle the knob to make sure it is in place properly, like this **(demonstration)**.”

“It is important to go through the procedure of wiggling and checking the knobs properly because the knobs are sometimes easily mistaken as off when they really are not.”

“Would you like me to repeat that, or is it okay to continue?”

****Repeat instructions if required****

“Let’s have a practice. Please turn on burners 4, 5 and 6. Please turn them off. Please check them.”

****If the participant makes an error correct them and demonstrate how to perform the check correctly****

****Remove stove stimulus****

(DOSSETTE BOX)

****Introduce dosette box stimulus****

“This is the dosette box, the days of the week, Sunday to Saturday, are labelled along the top and each compartment is labelled either morning, noon, evening or bed. Each compartment contains a capsule. When asked to open a compartment, for example Saturday bed, you would do so by opening the lid like this (*demonstration*). When asked to remove the capsule, you take the capsule from the compartment (*demonstration*). When asked to close the lid, you simply close the lid like this (*demonstration*). When asked to perform the check, you open the relevant compartment to make sure the right capsule was removed and then close it, like this (*demonstration*).”

“It is important to go through the procedure of opening and checking the compartments because you cannot see inside and they need to be opened to be checked.”

“Would you like me to repeat that, or is it okay to continue?”

****Repeat instructions if required****

“Let’s have a practice. Please open Sunday morning. Remove the capsule. Please close the lid. Please perform the check.”

****If the participant makes an error correct them and demonstrate how to perform the check correctly****

****Replace capsule and remove dosette box stimulus****

PRE-TRIAL:

****Introduce stove stimulus****

“Alright, I am now going to give you some instructions on the checks I’d like you to perform. I will pause until you have completed that part of the instruction but will not be able to give you any feedback from this point. Any questions?”

Administer PRE-TRIAL on appropriate sheet (Relevant Checking Series: Stove/ Irrelevant Checking Series: Dosette Box) based on their condition

****Remove stove stimulus****

“Now I’d like you to answer this sheet of questions. When you’re finished, just let me know.”

Give Response Sheet: Pre-Checking

RELEVANT/IRRELEVANT CHECKING:

*****RELEVANT/IRRELEVANT CHECKING determined by randomised assignment*****

“Alright, we will now start the sets of operations. There will be many operations to go through, and it is important to go through the actual physical procedure. Any questions?”

(RELEVANT CHECKING)****Introduce stove stimulus****

“Now, I’m going to give you some instructions to operate and check the replica stove the way you were shown earlier”.

Administer Trials T1 – T15 (Relevant Checking Series: Stove)**OR****(IRRELEVANT CHECKING)******Introduce dosette box stimulus****

“Now, I’m going to give you some instructions to check the dosette box the way you were shown earlier.”

Administer Trials T1 – T15 (Irrelevant Checking Series: Dosette Box)****Remove dosette box stimulus. Introduce stove stimulus****

“Now, I’d like you to operate the stove.”

POST TRIAL:***Administer POST TRIAL on appropriate sheet (Relevant Checking Series: Stove/ Irrelevant Checking Series: Dosette Box) based on their condition*******Remove stove stimulus****

“Now I’d like you to answer this sheet of questions. When you’re finished, just let me know.”

Give Response Sheet: Post-Checking**QUESTIONNAIRES:**

“Now, I’d like you to answer these questionnaires. There are no right or wrong answers. Just answer the questions at your own pace without spending too much time on any one question. When you’re finished, just let me know. Any questions?”

Give Questionnaire Pack (containing 5-item GDS, GAI-SF, PRMQ and the item adapted from the Fear of Alzheimer’s Disease Scale)

“Finally, I have some questions I’d like to ask. The first set will be a brief cognitive screen which looks at memory, orientation and attention and the second set will be demographic questions. Do you have any questions?”

Administer 6-CIT and Demographic Information Sheet

FOLLOW UP INFORMATION:

“Thank you for taking part in this study, please read this follow up information sheet”

Give Follow Up Information Sheet

“Do you have any other questions or comments about anything you did today or anything we've talked about?”

“If you do have any further questions about the study please feel free to contact either myself or my supervisor using the details on the follow up information sheet. Thank you again for your time.”