UNDERSTANDING SUBJECTIVE MEMORY COMPLAINTS IN AGEING

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Abstract

Everyday memory difficulties are a common experience with age, and cause considerable distress for many people when they are interpreted as potential indicators of age-related disease. However, research literature examining the relationship between these difficulties (known as *subjective memory complaints*; SMCs) and actual memory performance on neuropsychological tests has shown mixed results, suggesting that SMCs are not a pure reflection of memory ability, but instead that their aetiology is complicated and not fully understood. Both psychological and methodological factors are also implicated, although no research has yet comprehensively examined how a combination of these factors might predict SMCs.

The current research aimed to test a new aetiological model of SMCs that incorporated a range of potential confounds. It was hypothesised that SMCs would be predicted by measures of processing speed and executive functioning, and that this relationship would be moderated by measures of anxiety and depression.

First, a meta-analysis and systematic review of existing research on the relationship between subjective and objective memory was conducted as a platform to inform subsequent analyses. Then, Study A addressed current variation in assessment methods by describing differences in SMCs when assessed with both an open-ended measure and a prescriptive questionnaire. Study B examined how these differences in subjective reports related to objective memory performance. Finally, Study C tested the proposed aetiological model of SMCs.

Study A showed that different measures of SMCs garnered non-overlapping reports. SMCs gathered via the open-ended measure were fewer in number, but rated as more distressing, than those endorsed on the questionnaire. Spontaneous reports appeared to be more ecologically valid reflections of SMCs, although questionnaire assessments were by their nature more robust to a "catch 22" situation whereby some endorsed SMCs were not reported spontaneously (perhaps due to memory failures in themselves). Study B found that neither method of assessing SMCs produced reports that were significantly convergent with objective measures of memory functioning. Study C found partial support for the hypothesised aetiological model. SMCs (as assessed by the questionnaire) were inversely related to processing speed, but only when depressive symptoms were relatively high. Collectively, results offer important insights into the interaction of cognitive and psychological factors in explaining SMCs, and highlight the previously undelineated context in which processing speed contributes to SMCs.

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This thesis is far from mine alone - there are many people who made a difference to its final form and its existence at all. Most of all is my primary supervisor Professor Janet Leathem. Your experience and wisdom was instrumental in the quality of this project. No one else has simultaneously taught, inspired and encouraged me while still giving me room to grow independently. Thank you for your thoughtfulness, relentless positivity, and support.

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List of Abbreviations

BDI-II	Beck Depression Inventory (2nd edition)
CAMDEX	Cambridge Mental Disorders of the Elderly Examination
CES-D	Center for Epidemiological Studies Depression scale
CI	Cognitive Impairment
CRT	Coin Rotation Task
GDS	Geriatric Depression Scale
ICC	Intraclass Correlation Coefficient
IQ	Intelligence Quotient
M	Mean
MAC-Q	Memory Complaint Questionnaire
MCI	Mild Cognitive Impairment
MMQ-A	Meta-Memory Questionnaire (Ability subscale)
MMSE	Mini Mental State Examination
N	Number of participants
NART	National Adult Reading Test
NR	Not Reported
NS	No Screen used
RAVLT	Rey Auditory Verbal Learning Test
RCFT	Rey Complex Figure Test
SCC	Subjective Cognitive Complaint
SD	Standard Deviation
SMC	Subjective Memory Complaint
SMCQ	Subjective Memory Complaints Questionnaire
SPSS	Statistical Package for the Social Sciences
STAI	State-Trait Anxiety Inventory
TMT	Trail Making Test
WAIS-IV	Wechsler Adult Intelligence Scale (4th edition)

Preface

I came to doctoral study having previously enjoyed working with older adults who experienced language difficulties following a stroke. I wanted to conduct research that allowed me to further explore the challenges that ageing presents, while also expanding my experience into other aspects of neuropsychology beyond language abilities. One of my initial ideas was prompted by a participant I had worked particularly extensively with, who experienced severe non-fluent aphasia and depression following a stroke and the coincident death of his wife. However, background reading into post-stroke depression led me to realise that I would likely find greater fulfilment in an area which was more widely applicable to a range of older adults, and so I began looking into age-related changes in memory. I was interested in the age-prospective memory paradox at first, a phenomenon in which older adults tend to score lower than younger adults on laboratory-based tests of prospective memory, yet outperform younger adults when the prospective memory tasks are conducted in real-world settings. What attracted me to this topic was the focus on areas in which older adults showed cognitive strengths, a refreshing change from the focus on decline in many areas of ageing research.

Meetings with my supervisor at this time also resulted in discussions about other paradoxes related to ageing and cognitive functioning that she had noted as a clinician. In particular, we noted that many older adults (and often those not yet aged 65 as well) who reported memory difficulties often exhibited average or better scores on neuropsychological tests. Further reading into this area led to my learning of functional memory disorder (Schmidtke, 2008), a condition in which subjectively experienced memory difficulties have significant functional impact but are not detectable using traditional neuropsychological tests. At first I wondered whether I might be able to find such participants and further examine their cognitive functioning, however analysis of the likelihood of being able to find a reasonable number of participants with functional memory disorder within the research timeframe meant that this option was not tenable.

Instead, I continued to reflect on the large number of studies investigating the link between subjective and objective memory measures, and their enduringly discrepant results. I noticed possible reasons for this variation and coinciding gaps in the literature that I could address, such as direct comparisons of assessment methods. In combination with the questions raised by my supervisor about what was going on for people who experienced memory difficulties but performed normally on tests, this became the central topic of my research.

The initial hypothesis, driven by clinical observations, was that memory changes commonly attributed to ageing may reflect objective changes in processing speed rather than memory abilities per se, combined with anxiety about these age-related changes. In practical terms, this was exemplified by a commonly reported situation among clients, who would see someone they knew walking towards them on the street, but be unable to remember their name as the person drew closer. We wondered whether this situation, rather than reflecting errors in memory functioning, instead resulted from normal age-related declines in cognitive processing speed, which meant that names might take a fraction longer to recall than they had in the past. However before recall could occur, a person's anxiety about being able to remember the friend's name also increased and further hindered their recall. Such a hypothesis would explain why many people who reported memory difficulties did not show clinical impairment on formal tests of this ability.

Exploration of existing work on age-related changes in processing speed led to my learning about Timothy Salthouse's work and other theories of cognitive ageing, which now form a theoretical basis for the central hypothesis. I realised that this hypothesis could not be robustly tested without first investigating preliminary questions such as how best to assess these reported memory difficulties (known in the literature as *subjective memory complaints*) and the influence of assessment method on the relationship between subjective memory complaints and objective measures of memory functioning. These questions are therefore examined before the hypothesised model is tested. Reading about the age groups for which subjective memory complaints are relevant also prompted me to include middle-aged adults (i.e., from age 40 and up) in the research sample as well, as this is the age where reports of memory difficulties begin to increase (Ponds, van Boxtel, & Jolles, 2000) and cause significant worry (Lachman, 2004).

A final point to note is that terminology relating to the key topic varies in the literature. In order to accommodate this variation, initial theoretical chapters cover all age-related cognitive difficulties (including those related to memory), using the broader term of *subjective cognitive complaints* (except where otherwise identified as *subjective memory complaints* specifically). In Chapter 4, the focus narrows to subjective memory complaints only, and reasons for this shift are explained there.

Thesis Overview

This thesis has been written by publication, and contains four studies presented as manuscripts. Figure 1 shows the relationships between these studies and the intermediate chapters, and these are explained further below. There is some unavoidable repetition between chapters in order that the manuscript chapters are complete when read in isolation. Similarly, manuscript chapters also contain references at the end of each chapter, and references cited in other chapters are listed in the overall Reference List beginning on page 201.

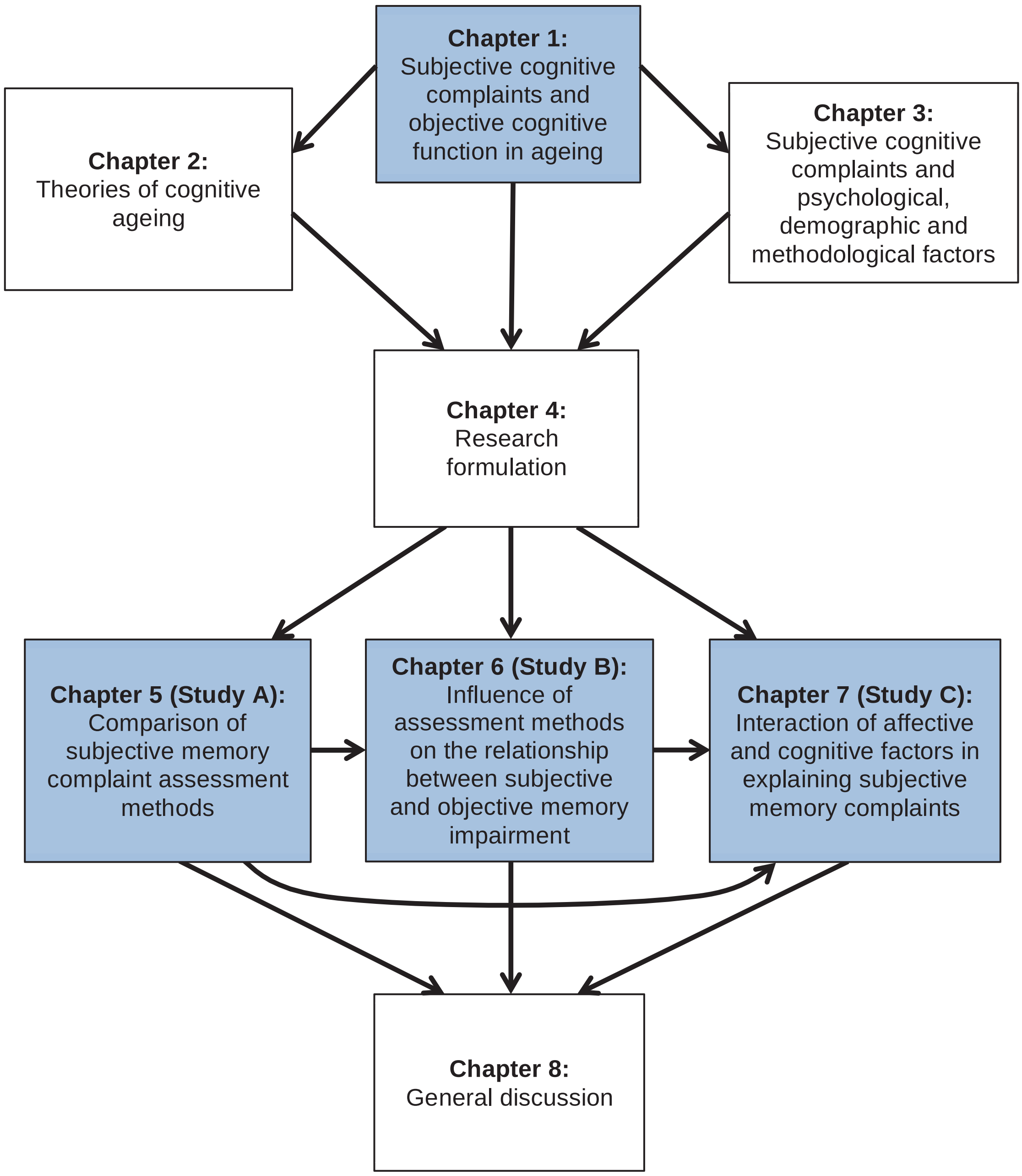

Figure 1. Relationships between chapters in the thesis.
Note. Blue boxes denote manuscript chapters. Appendix A contains the Statements of Contribution for published work (Chapters 1 and 5).

This thesis is structured so as to build towards a test of the central hypothesis in Study C (Chapter 7). It begins with a review of the literature regarding the relationship between subjective cognitive complaints and objective cognitive functioning (Chapter 1), followed by chapters which respectively review theories of cognitive ageing (Chapter 2), and the contribution of psychological, demographic and methodological factors to subjective memory complaints (Chapter 3). Chapter 4 brings these ideas together into a formulation of the proposed research and describes the methods used for the three studies.

The first study, reported in Chapter 5, investigates different methods of assessing subjective memory complaints. Chapter 6 builds on this work by examining how the different methods of assessing subjective memory complaints relate to measures of objective memory functioning. Both chapters inform the study in Chapter 7, which reports the test of the proposed aetiological model of subjective memory complaints (i.e., that SMCs will be predicted by processing speed, and that anxiety will moderate this relationship). Finally, Chapter 8 provides a general discussion of the research findings as a whole, including limitations, suggestions for future research, and some personal reflections.

CHAPTER 1

SUBJECTIVE COGNITIVE COMPLAINTS AND OBJECTIVE COGNITIVE FUNCTION IN AGEING: A SYSTEMATIC REVIEW AND META-ANALYSIS OF RECENT CROSS-SECTIONAL FINDINGS

This chapter has been published in *Neuropsychology Review*:

Burmester, B., Leathem, J., & Merrick, P. (2016). Subjective cognitive complaints and objective cognitive function in aging: A systematic review and meta-analysis of recent cross-sectional findings. *Neuropsychology Review, 26*(4), 376-393. doi:10.1007/s11065-016-9332-2

Abstract

Research investigating how subjective cognitive complaints (SCCs) might reliably indicate impairments in objective cognitive functioning has produced highly varied findings, and despite attempts to synthesise this literature (e.g., Jonker, Geerlings, & Schmand, 2000; Reid & MacLullich, 2006; Crumley, Stetler, & Horhota, 2014), recent work continues to offer little resolution. This review provides both quantitative and qualitative synthesis of research conducted since the last comprehensive review in 2006, with the aim of identifying reasons for these discrepancies that might provide fruitful avenues for future exploration. Meta-analysis found a small but significant association between SCCs and objective cognitive function, although it was limited by large heterogeneity between studies and evidence of potential publication bias. Often, assessments of SCCs and objective cognitive function were brief and/or not formally validated. However, studies that employed more comprehensive SCC measures tended to find that SCCs were associated independently with both objective cognitive function and depressive symptoms. Further explicit investigation of how assessment measures relate to reports of SCCs, and the validity of the proposed ‘compensation theory’ of SCC aetiology, is recommended.

Introduction

Many adults report an increasing number of memory and other cognitive difficulties as they grow older (Jonker, Geerlings, & Schmand, 2000; Ponds, van Boxtel, & Jolles, 2000) and often these are interpreted as indicators of cognitive decline and age-related cognitive disorders such as Alzheimer's disease and other forms of dementia (Paradise, Glozier, Naismith, Davenport, & Hickie, 2011). Subjective memory complaints in particular are a key diagnostic criterion for mild cognitive impairment (MCI), a transitional stage between normal age-related cognitive changes and those associated with dementia. However, recent literature has highlighted the questionable diagnostic validity of memory complaints for MCI (Stewart, 2012), due to mixed evidence regarding their link with objectively detectable memory impairments. Hence it is important to understand subjective cognitive complaints (SCCs) for their potential value in predicting the development of clinically relevant conditions. Additionally, middle-aged adults display high levels of worry about their memory functioning and future decline (Lachman, 2004), yet relatively few go on to develop cognitive disorders later in life. Thus SCCs may in fact signify a potentially unnecessary concern, which could be addressed through psychoeducation if research establishes that their predictive value is low. Despite a large number of studies investigating the link between SCCs and objective cognitive functioning, and existing reviews of this literature, subsequent work has not reached any further agreement on whether SCCs can be considered a reliable indicator of current impairment or risk of future cognitive decline.

This review will summarise the findings of recent literature in this area, and provide an update of work published since the last comprehensive review of cross-sectional studies by Reid and MacLullich (2006). The findings of existing reviews on this topic will be discussed in chronological order, followed by literature that has emerged since. Similarities and differences in findings will be examined, with a particular focus on other variables and methodological variations that may have influenced results, and subsequent suggestions will be made for areas that hold promise in clarifying the value of SCCs.

Early Reviews

Jonker and colleagues (2000). The first review of evidence concerning the relationship between subjective and objective cognition was specific to *memory* complaints and performance. Jonker et al. (2000) examined ten cross-sectional studies, and found that the association between memory complaints and memory performance depended on characteristics of the participants. Specifically, participants who self-referred to memory clinics tended to report memory complaints that were associated with their level of depressive symptomatology, whereas hospital-based samples showed a more consistent link between complaints and memory performance. Self-referred participant samples tended to be younger and thus there was less likelihood of age-related memory impairment being present. In contrast, complaints in relatively older samples were related to impairment, even after adjusting for depressive symptoms.

Jonker et al. (2000) also reviewed ten longitudinal studies that reported the association between memory complaints at a baseline data collection phase and cognitive outcomes at various follow-up periods. Here, findings were more consistent, with memory complaints predicting future dementia diagnoses (where the follow-up period was at least two years) and general cognitive decline (in follow-up periods as little as one year). Furthermore, this relationship was often found even when participants with depressive symptoms were excluded from analyses. The link was especially true for participants diagnosed with MCI at baseline, and also held greater value for participants who did not have baseline MCI but who were highly educated. The authors suggest that this specificity may be because highly educated participants are more sensitive to subtle changes in their cognitive functioning, although they still perform relatively well on objective tests due to the ceiling effects of commonly used short screening tests such as the Mini Mental State Examination (MMSE).

Ultimately, Jonker and colleagues (2000) concluded that memory complaints in older adults could be signs of future decline and conditions such as dementia, and therefore they warranted further investigation by clinicians. Even in cases where there was no evidence of memory impairment and complaints might be thought to reflect depressive symptoms instead, the possibility of future decline should not be discounted and SCCs still monitored for change and functional impact.

Reid and MacLullich (2006). Following on from Jonker et al. (2000), Reid and MacLullich (2006) aimed to include more recent literature on the link between subjective and objective memory, and to investigate the impact of depression and neuroticism on findings. Six population-based cross-sectional studies were selected after omitting those that recruited participants via self-referral or health care practitioners. Some studies reported positive associations between memory complaints and memory impairment, but were vulnerable to methodological limitations such as non-validated measures of complaints, limited assessment of objective functioning, and failing to assess confounding depression and/or personality variables. Other studies with more comprehensive measures of objective function reported weak or no associations between complaints and performance. Reid and MacLullich (2006) concluded that the methodological limitations of all cross-sectional studies meant that there was insufficient evidence to make definitive statements about the link between subjective memory complaints and objective memory impairment.

Fifteen longitudinal studies were also examined for links between memory complaints and later cognitive decline, and here the authors agreed with Jonker and colleagues' (2000) conclusions that memory complaints at baseline did predict later cognitive decline and/or dementia. However, they highlight that the predictive value of memory complaints might still be somewhat limited in this regard, and evidence of memory impairment at baseline might also be needed in order for greater predictive power. Methodological limitations were also detrimental to longitudinal studies, with non-validated assessments of complaints again being widely used, and a relative lack of measurement of other variables such as depression and personality factors.

Evidence from studies that did examine the role of depression and personality traits led Reid and MacLullich (2006) to conclude that these variables were more strongly related to subjective memory complaints than was objective memory impairment. They highlighted that depression and personality variables were related to memory complaints even in the absence of clinical levels of depression, and that links between depression and/or neuroticism and performance on cognitive testing might in fact explain any consequent association between objective impairment and subjective complaints. This conclusion conflicts with an assertion from Jonker et al. (2000) that subjective complaints and objective impairment were related in older cohorts even when controlling for depression. Such discrepancies, combined with the considerable methodological limitations mentioned in both reviews, points to a need for still further research that attempts to account for these problems.

Recent Reviews

More recently, three notable reviews have emerged and are briefly summarised here. The first included both cross-sectional and longitudinal studies, while the latter two were limited to longitudinal studies only.

Crumley, Stetler, and Horhota (2014). These authors conducted a meta-analysis of studies to February 2012 that examined the relationship between subjective and objective memory in ageing. Over 53 studies and 20,319 participants, a significant but very small effect size was observed, where subjective memory measures explained less than one percent of the variance in participants' performance on objective memory measures. Further, the effect was moderated by a number of demographic and measurement-related variables, with the relationship being stronger for participants who were generally older, female, well educated, and less depressed, and when subjective memory was assessed by questionnaires rather than interviews (the longer the better), interpreted as capacity of memory rather than complaints, and included measures of prospective objective memory. However, a major limitation of this review was that the terms used to search databases for literature included the names of five specific questionnaires about subjective memory, meaning that the studies included were likely limited to only those that included at least one of these measures. Given that the assessment of subjective memory varies widely with no established common measures or methods (Rabin et al., 2015), the use of narrow search terms potentially excludes a large number of relevant studies that used other questionnaires or any non-questionnaire methods of assessment. Further, this study did not make any distinction between cross-sectional and longitudinal studies reviewed, unlike previous reviews. This is surprising given that earlier reviews highlighted different conclusions regarding these two types of studies (Jonker et al., 2000; Reid & MacLullich, 2006), and thus conflating the two increases the potential error in findings.

Mitchell, Beaumont, Ferguson, Yadegarfar, and Stubbs (2014). This study was a meta-analysis of the longitudinal value of subjective memory complaints for predicting MCI and dementia. Thirty-two studies representing a total of 29,723 participants were analysed, with an average follow-up period of 4.8 years. Over this time, the rates of conversion to dementia were approximately twice as high (i.e., 2.3% vs. 1%) for participants who reported memory complaints at baseline assessments than those who did not report complaints. Rates of conversion to MCI were also increased for participants with initial memory complaints. The authors concluded that subjective memory complaints have significant clinical value as prognostic indicators, however a major limitation of the work to date is the heterogeneity between samples and studies (e.g., community-based vs. memory clinic samples, definitions of memory complaints, assessment of different types of complaints).

Mendonça, Alves, and Bugalho (2016). This study focused on the use of SCCs (not just memory complaints) as an indicator of later dementia diagnoses, and presented a systematic review of seventeen studies. Their conclusions parallel those of Mitchell et al.

(2014) in that the risk of developing dementia was 1.5-3 times greater for participants with SCCs at baseline. They highlight that despite the increased risk, the overwhelming majority of participants with SCCs do not develop dementia (at least within the time courses measured). Issues affecting the predictive value of SCCs were also noted, including the influence of depressive symptoms, the lack of a "gold standard" validated measure of SCCs, and confounding of different aspects of SCCs (e.g., severity vs. frequency vs. functional impact).

Current Review

Despite a persistent lack of clarity regarding their value as indicators of impairment, SCCs remain of interest to researchers and clinicians because they are so salient to participants and patients (Begum, Morgan, Chiu, Tylee, & Stewart, 2012; Paradise et al., 2011). Accurate perceptions of one's own memory functioning is necessary in order to engage with effective interventions and compensatory strategies (Lachman & Andreoletti, 2006), and prevent subsequent negative impacts of SCCs on mood and self-efficacy (Mol et al., 2007). As such, a sound understanding of the conditions under which SCCs can have greatest predictive value is required and warranted given the abundance of new studies that have emerged since the last comprehensive review on this topic (Reid & MacLullich, 2006). The current review will discuss this recent literature and provide an update of previous review findings, as well as providing a quantitative assessment of the association between SCCs and objective cognitive functioning in the form of a meta-analysis. Where early reviews examined both cross-sectional and longitudinal studies, this review is limited to cross-sectional studies only, as the longitudinal value of SCCs has been more recently examined in depth (see Mendonça et al., 2016; Mitchell et al., 2014) while the most recent review of cross-sectional work was limited to studies which included prescribed subjective measures and conflated these with longitudinal findings (Crumley et al., 2014). As in previous reviews, methodological choices, the contribution of depression, and other major confounds in the relationship between SCCs and objective performance are considered throughout.

This review also considers the broader category of subjective *cognitive* complaints rather than limiting findings to memory complaints specifically. While previous work has concentrated on memory complaints specifically, and sometimes conflated these with other types of subjective cognitive complaints (e.g., Clément, Belleville, & Gauthier, 2008; Hohman, Beason-Held, Lamar, & Resnick, 2011), recent work emphasises the value of all types of cognitive complaint (Rabin et al., 2015). This distinction is addressed in the current review through analysis of how complaints relate to performance at the broad cognitive level as well as specific to memory.

Recent progress in the field has highlighted the relationship between SCCs and biological factors such as amyloid deposits and apolipoprotein E4 alleles (e.g., Amariglio et al., 2012; Buckley et al., 2013), however these are outside the scope of the current review. Here, analysis is limited to behavioural and cognitive correlates of SCCs as these reflect the focus on the significance of SCCs in normal ageing rather than in disease-related processes, and signify the factors which are more immediately accessible to most clinicians and the general public.

Reid and MacLullich (2006) excluded cross-sectional studies that used community-based samples of volunteer participants, but these are included in the present review in order to better reflect findings from all samples. While volunteer samples are subject to selection biases, they do comprise the majority of studies regarding SCCs and objective cognitive functioning, and also reflect the effects of SCCs in the very people for which they cause most distress. Therefore, knowledge about how SCCs in these samples relate to cognitive performance is important in understanding how best to alleviate this distress.

Method

Articles were selected from PsycINFO and Web of Science using the following keyword search terms: (*subjective memory complaints* OR *subjective cognitive complaints* OR *subjective memory decline* OR *subjective cognitive decline*) AND (*memory impairment*

OR *cognitive impairment* OR *cognitive disorder* OR *memory decline* OR *cognitive decline*). Inclusion criteria were that the articles were published between January 2006 and May 2016 (inclusive), and concerned the relationship between SCCs and cognitive performance/impairment in ageing. Articles were excluded if they were not in English, were not a peer-reviewed research study (i.e., a review, editorial, conference proceedings or dissertation), did not contain a measure of either SCCs or cognitive function or did not report the association between these two variables, sampled or contained a majority of participants from a special population (e.g., people with chronic fatigue syndrome, epilepsy, MCI, or perimenopausal women), did not explicitly aim to examine the cross-sectional association between SCCs and cognitive function, reported only longitudinal associations, or only reported associations for groups which included a majority of participants younger than 40. Titles were screened first, followed by abstracts and then full article texts. Figure 2 shows the number of articles included at each stage of selection. This process resulted in the inclusion of 53 studies.

Notes on Terminology

Many different measures of various aspects of memory and other cognitive functions have been used among the studies reviewed here, and the terms used to refer to these constructs can foster some confusion. Here, *memory* performance/impairment refers to scores on memory-specific measures (e.g., Rey Auditory Verbal Learning Test), whereas *cognitive* performance/impairment is used to describe scores on a broader range of cognitive measures (not specific to memory, e.g., MMSE).

As noted earlier, literature has conflated the terms *memory complaint* and *cognitive complaint*, although the former would intuitively appear to be a sub-category of the latter. Study participants also appear to categorise a range of non-memory related difficulties (such as difficulty concentrating) as memory-related difficulties (Apolinario et al., 2012; Snitz et al., 2015), and global measures of subjective cognitive functioning often refer only to memory

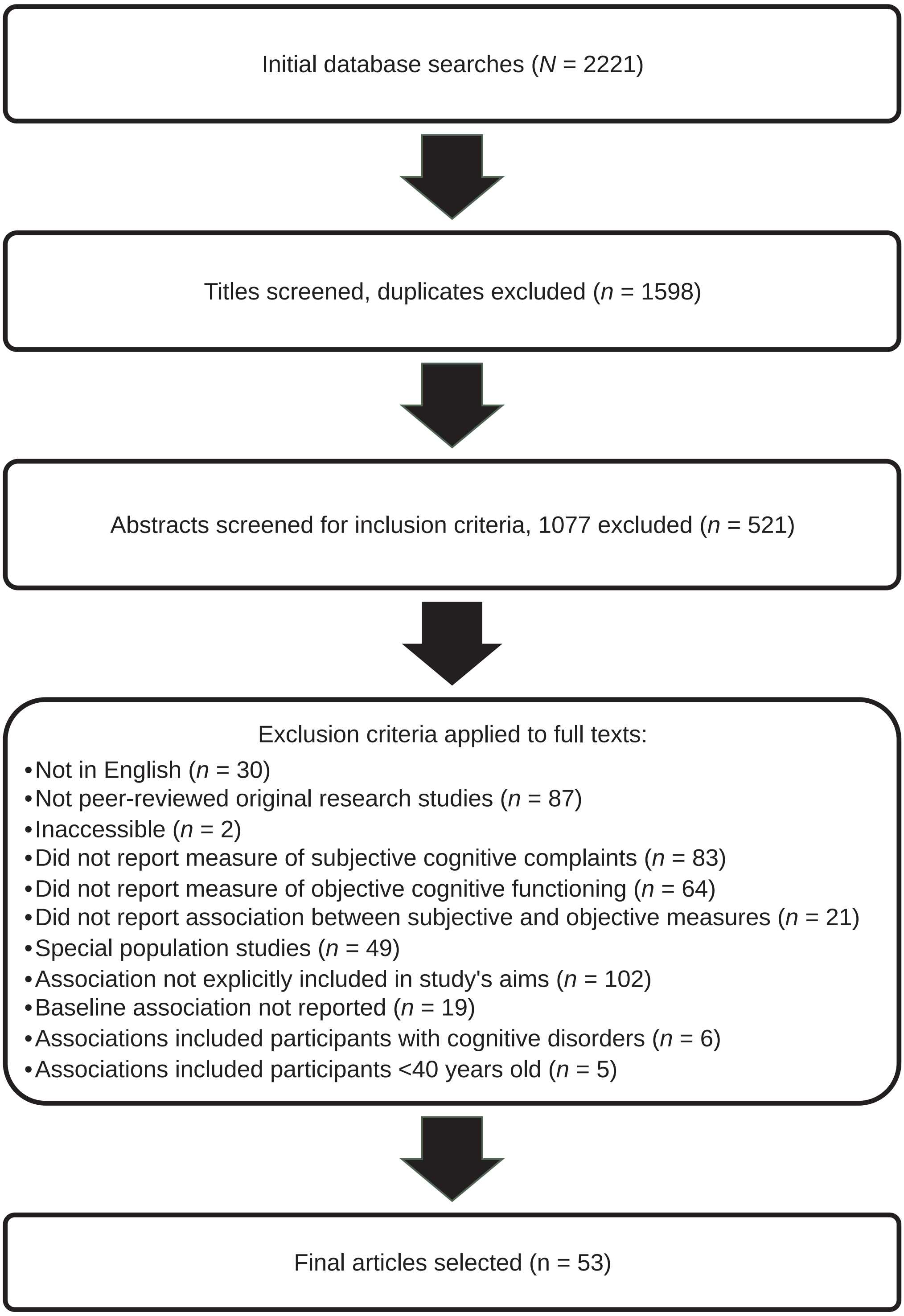

Figure 2. Selection process for study inclusion.

specifically (Rabin et al., 2015; Snitz et al., 2015). Consequently, the term *subjective cognitive complaint* will be used here to refer to reported difficulties of both memory and other cognitive domains (consistent with recommendations from Reisberg & Gauthier, 2008), although it is acknowledged that many studies may only explicitly assess memory complaints specifically. However, both *memory complaint* and *cognitive complaint* are included in the search terms in order to maximise the number of potential studies identified for review.

Finally, lay perceptions of the term *complaint* can carry pejorative connotations for participants and the general public. Here, this term is retained in order to be consistent with previous academic literature, however we recommend use of more validating terms (such as *symptoms*, *problems*, or *difficulties*) in clinical and other public settings. Indeed, measures of subjective cognitive functioning often use such language in their questions (e.g., “Do you have memory problems?”; Montejo, Montenegro, Fernández, & Maestú, 2011).

Statistical Analysis

Pearson *r* correlations between subjective memory complaints and objective cognitive performance were extracted from each included study. Where studies reported more than one effect size, the resultant correlations were averaged to give an overall effect size for that study. Where a study reported both cross-sectional and longitudinal data, only one set of cross-sectional results (usually baseline data) was included in this review. Where multiple studies were linked to the same participant pool, only data from the study with the larger sample size was used. Where studies included a subset of participants with cognitive impairments (e.g., MCI, dementia), only data from cognitively normal participants was used (where available). When this information was not available, studies were only included if the proportion of participants with cognitive impairment was less than 20%. All quantitative meta-analysis procedures were conducted with Meta-Essentials, using a random effects model which balances the relative weights of effect sizes so that studies with large sample sizes do not overshadow the contributions of smaller studies to the analysis (Borenstein, Hedges, Higgins, & Rothstein, 2007).

Results

Meta-analysis

After excluding studies with duplicate participant pools ($n = 3$), 50 studies were included in the meta-analysis. These studies represented a total of 58,778 participants (56,873 cognitively unimpaired; $M = 1159.20$, $SD = 2789.68$, range = 23 to 16964). Full details of the studies' characteristics are shown in Table 1.

The meta-analysis model showed a small but significant correlation between subjective memory complaints and objective cognitive performance ($r = -.13$, 95% CI [-.16, -.10], $Z = -.26$, $p < .001$), where greater/more severe memory complaints were associated with poorer performance on cognitive tests. Effect sizes with 95% confidence intervals for all studies are shown in Figure 3. Although Orwin's fail-safe N was relatively large (119), a funnel plot indicated potential influence of publication bias (reducing the estimate of effect size to $r = -.09$; see Figure 4), and effect sizes were significantly heterogeneous ($Q(49) = 1504.37$, $p < .001$, $I^2 = 96.74\%$), necessitating a cautious approach to interpretation.

Due to the high degree of heterogeneity among studies, subgroup analyses were conducted. Firstly, correlations specific to measures of memory only (both subjective and objective) were analysed as a subgroup. Secondly, studies that only reported effect sizes after controlling for other variables (e.g., age, gender, education) were analysed separately from those that reported effect sizes without controlling for other variables. Thirdly, studies were analysed in groups according to whether their measure of SCCs was a global question(s) (e.g., "Do you have problems with your memory?"), a number of specific examples (e.g., "Do you forget where you have put things?") as in a questionnaire, or a mix of both types. Finally, studies which screened for, and did not include any participants with, cognitive impairment were analysed separately to those that potentially or explicitly included participants with cognitive impairment. Results of all subgroup meta-analyses are shown in Table 2. The largest correlations obtained were for studies that used global measures of SCCs and when all

Table 1. Characteristics of Included Studies

Study	*N*	Age range (*M*±*SD*)	% female	CI (*n*)	SCC	Objective cognitive function	Depression	Controlled variables	Cognition		Memory	
									k	*r*	*k*	*r*
Amariglio et al. (2011)	16964	70-81 (74±1.5)	100.00	NS	2	1, 2, 5, 7	1	1, 4	28	-0.07	7	-0.08
Balash et al. (2013)	636	50-98 (68±9.8)	61.10	0	1	1	3	-	1	-0.11	1	0.00
Benito-León et al. (2010)	2146	65+ (75.7±5.85)	60.50	337	1	1, 2, 5, 7, 8	1	-	11	-0.04	5	-0.05
Brucki and Nitrini (2009)	163	50+ (62.3±9.16)	50.30	NS	1	1, 2		-	6	-0.17	4	-0.19
Buckley et al. (2013)	674	NR (72.7±6.7)	58.00	0	3	2	2, 9	1, 3, 8	3	-0.10	3	-0.10
Buelow et al. (2014)	84	55+ (68.5±8.64)	68.00	0	2	1, 2		1, 3	7	-0.01	3	-0.13
Calabria et al. (2011)	112	NR (70.8±6.2)	77.68	10	2	2		-	1	-0.14	1	-0.14
Caramelli and Beato (2008)	60	60-91 (69.9±6.3)	65.00	0	3	2, 3, 5, 6	10	-	10	-0.10	5	-0.08
Chin et al. (2014)	108	50+ (63.35±7.33)	70.37	0	2	2, 3, 5, 7	3	-	11	0.02	3	-0.01
Clément et al. (2008)	81	50-87 (68.59±8.2)	87.43	0	2	1, 2, 5, 6	4	2	18	-0.07	6	-0.15
Cook and Marsiske (2006)	57	65+ (74.77±5.03)	63.20	0	2	1, 2, 5, 7, 8	2, 5	-	5	-0.12	2	-0.17
Cooper et al. (2011)	2022	60+ (NR)	NR	0	1	1	11	-	2	-0.08	-	-
de Jager et al. (2009)	98	60+ (77.18±5.9)	NR	0	3	1, 2, 3, 4		1, 2, 3	12	-0.16	5	-0.14
Dux et al. (2008)	130	NR (76.7±8.5)	71.80	0	2	1, 2	2	-	3	-0.28	3	-0.26
Fernández-Blázquez et al. (2016)	608	70-85 (74.14±3.83)	62.00	0	2	1, 2, 4, 5, 6	2	-	16	-0.06	9	-0.07
Gavett et al. (2011)	384	60+ (70.37±6.6)	100.00	0	2	1, 2, 5	2	-	4	-0.07	-	-

Study	*N*	Age range (*M*±*SD*)	% female	CI (*n*)	SCC	Objective cognitive function	Depression	Controlled variables	Cognition		Memory	
									k	*r*	*k*	*r*
Genziani et al. (2013)	2775	65+ (74.3±NR)	60.70	0	1	2, 5	5	-	3	-0.10	1	-0.09
Grambaite et al. (2013)	23	45-79 (48.8±7.2)	56.50	0	1	2, 3, 5	3, 8	-	8	-0.34	2	-0.38
Jacinto et al. (2014)	248	65+ (NR)	NR	21	1	1	3	-	1	-0.38	-	-
Juncos-Rabadan et al. (2012)	580	50+ (NR)	69.10	0	2	1, 2	3	-	1	-0.15	-	-
Langlois and Belleville (2014)	115	45-87 (67.6±8.9)	82.00	0	2	1, 2, 4, 5, 6, 7	4	-	62	-0.04	21	-0.11
Lee et al. (2016)	77	60+ (NR)	53.00	0	3	2	7	1, 3, 4, 5, 6	2	-0.10	2	-0.10
Lucas et al. (2016)	72	61-78 (66.57±3.79)	72.20	0	2	1, 2, 4, 5	9	-	4	-0.29	4	-0.29
Martins et al. (2012)	479	50-95 (66±9.1)	60.30	0	2	2, 3, 4, 5, 7	3	1, 2, 4, 7	30	0.04	8	-0.06
Mendes et al. (2008)	292	18-87 (50.5±17.1)	48.00	0	2	2	3	-	4	-0.05*	-	-
Merema et al. (2012)	121	66-90 (73.83±6.34)	67.00	0	2	2, 8	7	-	5	-0.09	4	-0.14
Mewton et al. (2014)	1905	65-85 (NR)	52.63	297	1	1	12	-	4	-0.16	-	-
Minett et al. (2008)	114	50+ (66.15±NR)	88.00	0	3	1, 2, 3, 4, 5	3	-	14	-0.11	4	-0.05
Mol et al. (2006)	557	55+ (67.53±7.59)	49.45	0	1	2, 4, 5	8	1, 2, 3, 4, 5	5	-0.08	2	-0.09
Montejo et al. (2011)	1618	65+ (74.67±6.91)	60.42	0	1	1	1	-	1	-0.54	-	-
Montejo et al. (2014)	269	65-87 (71.47±5.03)	75.84	0	3	1, 2	2	-	6	-0.12	4	-0.12
Ossher et al. (2013)	105	65+ (75.3±6.8)	66.00	0	2	1, 2		-	3	-0.14	2	-0.09
Parisi et al. (2011)	1401	65+ (73.8±6)	75.00	0	2	2	5	1, 2, 3, 4, 9, 10	1	-0.29	1	-0.29

Study	*N*	Age range (*M*±*SD*)	% female	CI (*n*)	SCC	Objective cognitive function	Depression	Controlled variables	Cognition		Memory	
									k	*r*	*k*	*r*
Park et al. (2007)	9477	65+ (72.61±5.76)	60.60	1189	1	1, 2, 5, 6		-	1	-0.42	-	-
Pearman et al. (2014)	406	70-103 (83.33±8.45)	50.00	0	3	2	13	-	1	-0.08	-	-
Ramlall et al. (2013)	302	60-94 (73.5±7.7)	72.22	51	1	1	2	-	2	-0.02	-	-
Rijs et al. (2013)	891	55-64 (60.19±2.87)	52.36	0	1	2		1, 2, 11	2	-0.07	2	-0.07
Rönnlund et al. (2011)	255	60-90 (NR)	48.80	0	2	2	5	-	1	-0.05	-	-
Rouch et al. (2008)	907	62-68 (NR)	60.75	0	2	1, 2, 3, 4, 5	14	2, 3	17	-0.02	6	0.08
Shmotkin et al. (2013)	164	87-106 (NR)	57.00	NS	1	1	5	-	2	-0.07	-	-
Sims et al. (2011)	579	48-95 (68.99±9.68)	75.10	0	3	1, 2, 3	5	-	6	0.00	6	0.00
Snitz et al. (2008)	276	65-93 (73.2±5.6)	58.00	0	1	2, 4, 5, 7	6	-	12	-0.16	6	-0.20
Steinberg et al. (2013)	125	65-95 (77±7.2)	66.00	0	2	2, 3, 4, 5	3, 7	1, 2, 3, 9	9	-0.17	3	-0.16
Stenfors et al. (2013)	233	25-67 (48.67±10.39)	75.97	NS	NR	3, 5	8, 15	1, 2, 3	8	-0.12	-	-
Tomita et al. (2014)	394	60+ (68.7±6.3)	64.97	0	1	1	5	1, 2, 3, 4	1	-0.02	-	-
Trouton et al. (2006)	647	65-99 (75.8±NR)	59.94	0	3	1, 2	16	-	1	-0.32	-	-
van Oijen et al. (2007)	6927	55+ (69.5±9.1)	60.00	0	1	1	1	1, 2	1	-0.13	-	-
Waldorff et al. (2012)	753	65+ (NR)	61.21	0	1	1		-	1	-0.05	-	-
Zeintl et al. (2006)	364	65-80 (73±4.43)	46.00	0	2	2	3	-	1	-0.09	1	-0.09
Zlatar et al. (2014)	1000	51-99 (77.3±12.2)	51.40	0	2	1	17	-	1	-0.12	-	-

Note. N = sample size used in meta-analysis; M = mean, SD = standard deviation, NR = not reported; CI (n) = number of participants with cognitive impairment, NS = no screen used; SCC = subjective cognitive complaint measure type: 1 = global measures, 2 = specific examples, 3 = mixed; Objective cognitive function domains assessed: 1 = global, 2 = memory, 3 = attention/working memory, 4 = speed, 5 = executive functioning, 6 = visual-spatial abilities, 7 = language, 8 = pre-morbid functioning; Depression measure: 1 = global question(s), 2 = Geriatric Depression Scale (GDS; 30 items), 3 = GDS (15 items), 4 = GDS (5 items), 5 = Center for Epidemiological Studies Depression scale (CES-D), 6 = modified CES-D, 7 = Depression, Anxiety and Stress Scale – depression subscale, 8 = Symptom Checklist, 9 = Hospital Anxiety and Depression Scale (depression subscale), 10 = Cornell Scale for Depression, 11 = Revised Clinical Interview Schedule (depression subscale), 12 = World Mental Health Composite International Diagnostic Interview diagnosis, 13 = Hamilton Depression Scale, 14 = QD2A questionnaire, 15 = Major Depression Inventory, 16 = short Comprehensive Assessment and Referral Evaluation interview (depression subscale), 17 = Patient Health Questionnaire; Controlled variables: 1 = age, 2 = gender, 3 = education, 4 = depression, 5 = anxiety, 6 = stress, 7 = household type, 8 = apolipoprotein E4 allele status, 9 = ethnicity, 10 = health, 11 = region; k = number of effect sizes; r = Pearson correlation; * = Correlation relates only to data for participants aged 40+ (n = 205).

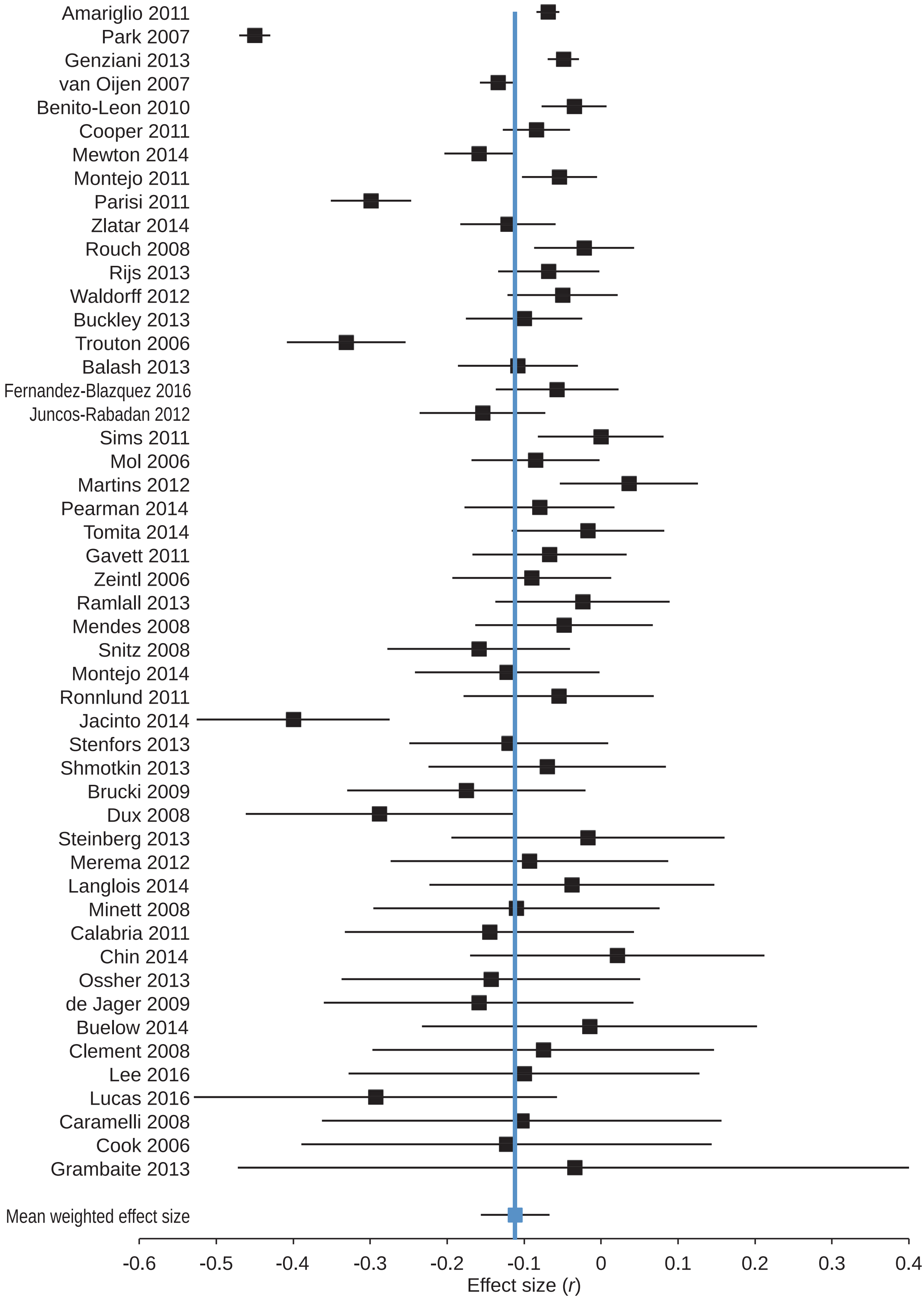

Figure 3. Forest plot of individual and mean weighted effect sizes.

Note. Individual effect sizes are displayed with error bars in order of standard error (smallest to largest). The blue line represents the mean weighted effect size (-.13).

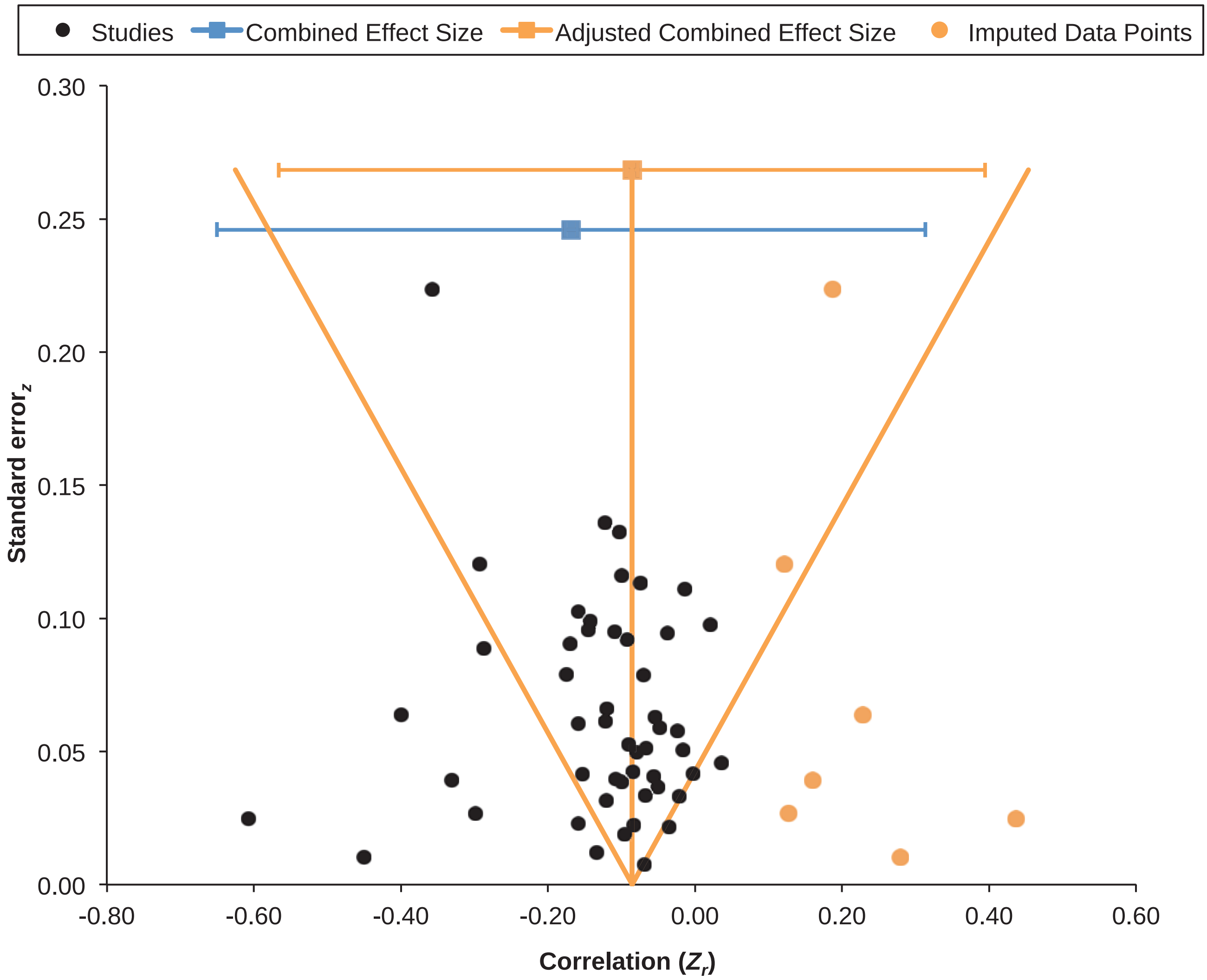

Figure 4. Funnel plot of observed studies' effect sizes and corrections for potential publication bias.

participants with cognitive impairment were excluded from analyses (r = -.16 for both). Heterogeneity was most reduced when only measures specific to memory were included in the analysis (I^2 = 74.26%).

Subsidiary Analysis

Due to the large heterogeneity among studies, and small numbers of studies which shared the same categories of moderator variables in some instances (e.g., used the same measure of depression, excluded participants with cognitive impairment, and reported data without controlling for other variables), studies included in the meta-analysis are discussed in further detail here, along with a review of the influence of potential moderator variables.

Table 2. Results of Subgroup Meta-Analyses

Category	Subgroup	*n*	*r*	95% CI (lower)	95% CI (upper)	*Q*	*p*(Q)	I^2 (%)
Participants with cognitive impairment	Potentially included	10	-.12	-.16	-.08	967.12	< .001	99.07
	Excluded	40	-.16	-.27	-.06	506.68	< .001	92.30
Influence of other variables	Controlled	15	-.15	-.19	-.10	97.72	< .001	85.67
	Uncontrolled	35	-.09	-.14	-.05	1061.22	< .001	96.80
SCC measures	Global	18	-.16	-.25	-.08	1049.58	< .001	98.38
	Specific	22	-.10	-.14	-.06	95.61	< .001	78.04
	Mixed	9	-.12	-.20	-.05	37.15	< .001	78.46
Objective measures	Memory only	32	-.10	-.13	-.07	120.43	< .001	74.26
Overall		50	-.13	-.16	-.10	1504.37	< .001	96.74

Evidence for a link with objective performance. Since 2006, many cross-sectional studies have found evidence that SCCs are associated with performance on objective tests of cognitive functioning. However, often the exact nature of this link has been unclear. For example, studies of relatively small numbers of community dwelling volunteers found that SCCs (as assessed via the Everyday Memory Questionnaire or four questions from the Cambridge Mental Disorders of the Elderly Examination [CAMDEX]) were associated with greater rates of diagnosed cognitive impairment (Jacinto, Brucki, Porto, Martins, & Nitrini, 2014) or poorer performance on tests such as the MMSE and CAMDEX objective assessment of functioning (Calabria et al., 2011; de Jager, Schrijnemaekers, Honey, & Budge, 2009; Ossher, Flegal, & Lustig, 2013). Population-based samples have also shown associations between SCCs and poorer performance on both global measures of cognition (Montejo et al., 2011; Waldorff, Siersma, Vogel, & Waldemar, 2012) and verbal memory specifically (Rijs, Comijs, van den Kommer, & Deeg, 2013). However, these studies were all limited by either brief global assessments of cognition rather than performance on more specific tests (Calabria et al., 2011; de Jager et al., 2009; Montejo et al., 2011; Ossher et al., 2013) or single-question measures of SCCs (Jacinto et al., 2014; Rijs et al., 2013; Waldorff et al., 2012).

All of these studies also omitted a measure of depressive symptoms, which have been highlighted in previous work (e.g., Reid & MacLullich, 2006) as one of the most important confounds in explaining potential links between SCCs and objective performance. Further studies assessed depression but did not include it as a potential statistical confound and so the weight of their conclusions is also limited. Balash et al. (2013) and Steinberg et al. (2013) both found SCCs to be associated with depression and objective cognitive performance, but as analyses were limited to correlations, collinearity effects could not be disentangled. Similarly, Grambaite et al. (2013) found that depressive symptoms predicted SCCs and objective performance, but did not examine these variables in a joint model. Fernández-Blázquez, Ávila-Villanueva, Maestú, and Medina (2016) also report that participants with SCCs tended to have lower objective test scores along with more depressive symptoms, however did not examine the interaction of these effects. Finally, van Oijen, de Jong, Hofman, Koudstaal, and Breteler (2007) found MMSE scores were significantly higher in participants without SCCs than those with SCCs regardless of whether participants with a history of depression were included in the analyses, however their focus was on longitudinal risk factors and so the cross-sectional influence of depressive symptoms was not explicitly examined.

Evidence for the influence of depression. Some studies that have statistically accounted for the influence of depression on the SCC-objective performance relationship report evidence that any association between SCCs and objective performance is reduced or eliminated once the effects of depressive symptoms are accounted for. For example, Balash et al. (2013) found the presence of SCCs in cognitively healthy participants was associated with greater depressive symptoms regardless of the participants' MMSE scores. Similarly, Zlatar, Moore, Palmer, Thompson, and Jeste (2014) found that SCCs were predicted by depressive symptoms irrespective of cognitive performance. Zeintl, Kliegel, Rast, and Zimprich (2006) also found depressive symptoms but not objective performance predicted prospective memory-related complaints. However, they do suggest that objective performance might hold greater predictive value in the absence of depressive symptoms, as this pattern was observed in a subgroup of the sample that reported fewer complaints. The regression model of Chin, Oh, Seo, and Na (2014) also showed that depressive symptoms and self-focused attention (awareness of internal thoughts and information) scores overshadowed the small contribution of verbal learning scores to predicting SCCs in participants without cognitive impairment. Finally, Genziani et al. (2013) and Montejo and colleagues (2014) found depressive symptoms to be a greater predictor of SCCs than objective memory performance, although both made independent significant contributions to the regression models.

Collectively, these studies offer methodological strengths in that they employed a range of measures for assessing both subjective and objective memory, excluded participants with diagnosed cognitive disorders, and included those both with and without depression. In most cases participants were volunteers in the study and thus likely had interest in or concern about their memory, although in one case (Balash et al., 2013) participants paid to be involved.

Consequently, the evidence from these studies that depressive symptoms are a stronger indicator of SCCs than objective performance is relatively reliable. However, the role of depressive symptoms may be limited to those who are already concerned about their memory, whereas in the wider population other aetiological factors may also be important.

Evidence against the influence of depression. By contrast, other studies found the link between SCCs and objective cognitive performance to be somewhat independent of depressive symptoms. Clément and colleagues (2008) administered the French-language Self Evaluation Questionnaire to volunteer participants, and found that participants' SCCs were not significantly associated with either objective functioning or depressive symptoms, which the authors interpreted as an indicator that this questionnaire might be particularly robust to the assessment of SCCs without also being confounded by depressive symptoms. Other work with both volunteer participants and random samples have found that objective cognitive function makes an additional significant contribution to a regression model of SCCs over and above that of affective symptoms (Martins, Mares, & Stilwell, 2012; Parisi et al., 2011; Snitz, Morrow, Rodriguez, Huber, & Saxton, 2008; Trouton, Stewart, & Prince, 2006), that SCCs are associated with objective performance and not depressive symptoms at all (Lucas et al., 2016; Mewton, Sachdev, Anderson, Sunderland, & Andrews, 2014), or that controlling for depressive symptoms makes very little difference to the association between SCCs and objective performance (Cook & Marsiske, 2006). These latter studies generally used comprehensive assessments of both subjective and objective cognitive functioning.

Similar results have been reported in three larger-scale studies that also found persistent links between SCCs and objective performance despite the influence of depressive symptoms (Amariglio, Townsend, Grodstein, Sperling, & Rentz, 2011; Benito-León, Mitchell, Vega, & Bermejo-Pareja, 2010; Rouch et al., 2008). However, these studies also highlight possible limits to the association between SCCs and objective performance. Benito-León et al. (2010) showed that SCCs were related to specific areas of cognitive function more than others, such as verbal fluency, naming, and free recall, while Rouch and colleagues (2008) found associations with measures of executive functioning (Trail Making Test) and processing speed (Digit Symbol Substitution Test) and suggest these cognitive domains should be further explored in individuals with SCCs. Alternatively, only specific types of SCCs (particularly uncommon examples such as “getting lost”) may be linked to cognitive functioning (Amariglio et al., 2011). Given the methodological strengths of large sample sizes and comprehensive assessment of objective cognitive functioning, these studies provide more weighty evidence that SCCs and objective performance are linked independently of depressive symptoms, although this may be limited to subsets of SCCs and/or domains of cognitive functioning. Results from Benito-León et al. (2010) and Rouch et al. (2008) also suggest that this link is present in more generalised population samples, as opposed to the evidence for affective aetiologies of SCCs in volunteer participants (discussed above).

Other confounds. As well as the influence of objective cognitive performance and depressive symptoms on SCCs, other studies have illuminated the impact of additional factors. First considering demographic variables, SCCs are generally more frequent in women than men (Brucki & Nitrini, 2009; Lucas et al., 2016; Martins et al., 2012), although Tomita et al. (2014) have found that the link between SCCs and objective cognitive functioning was specific to males (whereas in females SCCs were linked to affective measures). Further, Merema, Speelman, Kaczmarek, and Foster (2012) found the SCC-objective performance link was subject to the effects of age and pre-morbid IQ. SCCs also tend to be positively related to education level (Lucas et al., 2016), and this effect can confound the relationship between SCCs and objective performance (Genziani et al., 2013; van Oijen et al., 2007). However, SCCs do not appear to be related to employment status (Rijs et al., 2013).

Second, specific cognitive variables other than memory functioning have been uniquely linked to SCCs. As mentioned earlier, Benito-León et al. (2010) and Rouch et al. (2008) found links with measures of processing speed, executive functioning, and language measures. In addition, Mol, van Boxtel, Willems, and Jolles (2006) found SCCs were linked to slower processing speed but not memory performance, even after controlling for demographic and affective variables. However, Stenfors, Marklund, Hanson, Theorell, and Nilsson (2013) suggest that processing speed differences may not explain SCCs, but instead are related to difficulties in completing tasks that place high demands on cognitive resources. Other studies also support explanations relating to cognitive demands. Trouton et al. (2006) found that the relationship between SCCs and objective performance was strongest for participants with high levels of social activity, and interpret this factor as a practical indicator of cognitive demands in everyday life. Similarly, Martins et al. (2012) suggest that maintaining regular social interaction may prevent language-related SCCs such as word-finding difficulties and memory for proper names (although Genziani et al., 2013 provide results to the contrary). Alternatively, links between subjective and objective function may only exist for cognitive subgroups. A population-based study by Park and colleagues (2007) found that the degree of objective performance itself influenced the link with SCCs – SCCs and objective performance were associated only in those participants without cognitive impairment, and not in those with cognitive impairment (a ‘catch 22’ situation whereby participants may not remember to report all of their SCCs). Similarly, Fernández-Blázquez et al. (2016) found that the relationship between SCCs and objective performance was stronger for participants with a range of cognitive complaints than those with memory complaints alone.

Thirdly, psychological factors other than depressive symptoms also display unique influences in some cases. While broad measures of psychological symptoms tend to be strongly associated with SCCs (Brucki & Nitrini, 2009; Mewton et al., 2014), more specific constructs also exhibit influences. For example, Balash and colleagues (2013) found a significant association between anxiety and SCCs, although this was weak by absolute standards (Cohen, 1988) and smaller than the association with depression. Cooper et al. (2011) also found anxiety and somatic symptoms were associated with SCCs (along with depressive symptoms). Sims and colleagues (2011) highlight the importance of perceived stress and an externalised locus of control in explaining SCCs, and Dux et al. (2008) found that anxiety sensitivity affects the degree of congruence between subjective and objective memory measures.

Similarly, personality traits such as neuroticism and self-directedness are also correlated with SCCs (Pearman, Hertzog, & Gerstorf, 2014; Rönnlund, Vestergren, Mäntylä, & Nilsson, 2011). Other researchers suggest that age-related stereotypes and perceptions of one’s own age may influence SCCs (Langlois & Belleville, 2014; Pearman et al., 2014), and use of compensatory strategies may confound their relationship with performance (Langlois & Belleville, 2014).

Finally, the vulnerability of self-reports to failures of the cognitive abilities in question (i.e., forgetting to report memory difficulties) may limit the strength of any associations with objective functioning. Instead, reports may be more reliable when elicited from other people. For example, Juncos-Rabadan et al. (2012) found that memory difficulties were linked to objective performance only when they were elicited from an informant, not the participant themselves. Buelow, Tremont, Frakey, Grace, and Ott (2014), Gavett, Dunn, Stoddard, Harty, and Weintraub (2011), and Ramlall, Chipps, Bhigjee, and Pillay (2013) also found informant reports to have greater predictive validity than self-reports, particularly for participants with some degree of objective impairment.

The relevance of formal assessments to everyday difficulties may also limit findings. Langlois and Belleville (2014) highlight that the validity of laboratory-based tasks might be limited when compared to the everyday difficulties described in SCCs, and Lee et al. (2016) show evidence that ecologically valid tasks (such as those relating to prospective memory) can be more closely associated with SCCs than performance on more traditional measures of objective memory such as memory for word lists.

Absence of evidence for a link with objective performance. While all the studies discussed thus far have found some evidence for a link between SCCs and objective performance (whether it is related to other variables or independent of them), still others have found evidence to the contrary. Mendes et al. (2008) found no link between SCCs and objective performance across a wide range of age brackets, and instead SCCs were predicted only by depressive symptoms. Minett, Da Silva, Ortiz, and Bertolucci (2008) found that SCCs were not associated with performance on neuropsychological tests of language, attention, or memory and learning, except for that on a category fluency task. They suggest that this pattern could reflect greater functional impact of verbal semantic fluency than other cognitive difficulties. Ultimately however, Minett et al. (2008) concluded that the clinical validity of SCCs for detecting objective performance was poor. Similar results have also been reported in other volunteer samples (Caramelli & Beato, 2008; Shmotkin et al., 2013) and a larger sample by Buckley et al. (2013). These studies were usually limited in either their assessment of SCCs (Buckley et al., 2013; Caramelli & Beato, 2008; Minett, Da Silva, Ortiz, & Bertolucci, 2008) or objective performance (Shmotkin et al., 2013), which may account for the lack of associations observed.

Summary. Overall, cross-sectional studies included in this review tended to find limited support for a link between SCCs and concurrent objective performance. Links between SCCs and depressive symptoms were strong, and the influence of other cognitive and psychological variables were less well investigated but offer promising avenues for further research.

Studies that didn’t find a link between subjective and objective cognition at all were few in number and vulnerable to limitations in their assessments of either subjective or objective functioning. However, some studies that did find a link between SCCs and objective functioning were also limited by their assessment methods and omission of important confounds such as depressive symptoms.

Stronger evidence comes from more methodologically robust studies that tended to find evidence that SCCs are associated with depressive symptoms and/or objective cognitive functioning. A number of studies found that SCCs were more closely related to depressive symptoms than objective performance, which may indicate affective aetiologies of SCCs. That samples were also often limited to volunteer participants also supports this explanation. Such selection biases limit the external validity of conclusions, however they offer an important insight into the very people for whom the distress associated with SCCs causes them to seek help. Nevertheless, studies that used population-based samples still tended to find that SCCs and objective performance were linked independently of depressive and other affective symptoms, which suggests the predictive value of SCCs is not restricted to only "worried well" groups, but indicative of a more general relationship that might instead be confounded by methodological choices. In these studies, the SCC-objective performance link was instead shown to be specific to certain domains of cognitive functioning (Benito-León et al., 2010; Rouch et al., 2008) and perhaps only among participants who do not meet criteria for cognitive impairment (Park et al., 2007). Consequently, discrepant results may be due to variations in the measures used to assess objective performance, and therefore direct comparisons between various measures of objective performance and their respective associations with SCCs are warranted.

Suggestions for the role of other factors have also been found, with limited evidence (often from a single study) for the influence of other cognitive and psychological variables, as well as more consistent findings that SCCs are associated with demographic factors of female gender, older age, and more education.

Discussion

Previous reviews of literature concerning the value of SCCs for predicting objective performance have concluded both that SCCs can be a valid indicator of cognitive decline, particularly in older subgroups of older adults (e.g., those aged 75 and above) and those with high levels of education (Jonker et al., 2000), and that SCCs are not a consistent indicator of cognitive impairment (Reid & MacLullich, 2006). The current review updates evidence about the relationship between SCCs and objective performance from studies conducted since 2006, provides a meta-analysis of this relationship, and a narrative review of moderator variables.

Fifty studies were included in the primary meta-analysis, which showed a small but significant correlation between subjective and objective cognitive function, where poorer performance on cognitive tests was associated with greater frequency or severity of SCCs. This finding aligns with the most recent meta-analysis on this topic from Crumley et al. (2014). However, the studies included in the current review were highly heterogeneous and showed some potential influence of publication bias. Heterogeneity was reduced somewhat in subgroup analyses (most strongly when restricted to memory measures only) but still remained high overall. These limitations mean that such factors need to be taken into account when interpreting the results.

Systematic review of the included studies suggested that evidence for links between SCCs and objective cognitive function, as well as SCCs and depressive symptoms, were more robust than those which showed no association between SCCs and cognitive function. In particular, many studies were limited by brief assessments of either SCCs or objective cognitive function. Meta-analysis of subgroups indicated a similarly high level of heterogeneity among 18 studies which used global measures of SCC function as the overall result, whereas those that used specific examples of memory difficulties or a mix of the two types were more homogeneous.

Meta-analyses of other subgroups also tended to show small but significant relationships between SCCs and cognitive functioning, however systematic review of the included studies at a more detailed level provided suggestions for factors that contribute to the heterogeneity among studies. For example, some evidence summarised here suggests that in particular groups (e.g., the “worried well” that tend to comprise volunteer samples), SCCs mostly likely reflect depressive symptoms, however in general populations the link may exist independently of depressive symptoms. SCCs were also found to be related to particular cognitive domains (such as memory, executive functioning, and processing speed).

One proposed interpretation for these findings is that SCCs might lead to later objective performance when compensatory strategies are absent or ineffective. This understanding of SCC aetiology proposes that memory problems which develop with age can be divided into two groups: those which are initially problematic but later are effectively managed with compensation strategies and have little functional impact; and those which remain problematic in the absence of effective compensation. Current assessments of SCCs may tap only one of these types of memory concerns, and which type may differ between individuals (depending on whether they report difficulties which have occurred at some point or those which have continuing functional impact). The former type of memory difficulties may bear little relation to current functioning, while for the latter type of memory concerns, the absence of compensation may explain associations between SCCs and other variables such as depressive symptoms (failure to develop effective compensation may lead to depressive symptoms, or depressive symptoms may prevent effective compensation) and executive function abilities (participants with better executive functioning would be more likely to develop effective compensatory strategies through their problem-solving skills). Another possibility is that third-party factors give rise to both SCCs and other observed correlates. For example, beliefs about age-related declines in functioning may lead to both depressive symptoms and SCCs.

Other methodological aspects of the reviewed studies which could have affected the results obtained include wide variation in assessments of SCCs and objective performance across studies, and in particular assessment of SCCs often being limited to a single yes/no question not yet validated as an assessment tool. Brief assessments introduce greater error into measures, and in particular studies that used single yes-no questions as measures of SCCs are likely to be highly vulnerable to this source of error. Reid and MacLullich (2006) also discussed the lack of validated assessment of SCCs, as well as variation across studies in the measurement of cognitive function and criteria defining cognitive decline or impairment. Here, a pattern of comprehensive SCC assessment was found to co-occur with findings that SCCs were independently linked with both objective performance and depressive symptoms, which suggests that assessment shortcomings confound our understanding of the interplay between depression, SCCs, and objective performance. Recent progress has been made in this area, with Rabin et al. (2015) offering recommendations for future assessment of SCCs based on a review of numerous examples in the literature. Notably, their criteria suggest the use of specific examples rather than global questions regarding SCCs, which is supported by the current finding of less heterogeneity among the studies which used specific items.

Another issue raised in previous reviews on this topic concerns how the context in which studies are undertaken might influence the results, with community-based samples of older participants tending to find stronger evidence for the predictive value of SCCs than those with younger participants (Jonker et al., 2000). Here, the evidence did offer some support for the assertion that SCCs reported by younger volunteer samples may be related to psychological rather than cognitive factors (Balash et al., 2013; Chin et al., 2014; Montejo et al., 2014).

Of the psychological factors examined, depressive symptoms appear to have the greatest influence. Jonker et al. (2000) concluded that this was due to the lack of cognitive impairment in younger samples, meaning the relative influence of depressive symptoms was greater than in older samples. Reid and MacLullich (2006) also agreed that depressive symptoms likely play a significant role in accounting for the SCC-objective performance link, but suggest that depressive symptoms may result from SCCs rather than cause them. Here, depressive symptoms were also often linked to SCCs and objective performance; however many methodologically strong studies also found that SCCs and objective performance were independently linked even when depression was controlled for, suggesting that depressive symptoms likely have a primary, but not solitary, role in the development of SCCs.

Other variables that came up in a smaller number of studies included the role of informant reports of memory difficulties, which in some studies had greater predictive power for participants' objective performance than did their own self-reports (Buelow, et al., 2014; Gavett et al., 2011; Juncos-Rabadan et al., 2012; Ramlall et al., 2013). Demographic variables also showed some particular relationships, such as SCCs in women being cross-sectionally linked to psychological factors, while in men they were related to cognitive performance (Tomita et al., 2014). Such discrepancies could reflect the influence of study design on the findings, or other factors such as differing types of inaccuracies between genders. For example, recent work has found that men tend to overestimate their memory functioning whereas women underestimate it (Rickenbach, Agrigoroaei, & Lachman, 2015).

Of note is the relative absence of findings regarding the influence of anxiety and neuroticism, which have been highlighted in previous reviews. Only Balash and colleagues (2013) have noted a significant association between SCCs and anxiety, which was overshadowed by a stronger link with depression. Clinical practice would suggest a greater prevalence of anxiety symptoms among people with SCCs, and indeed work prior to the period covered here supports this (Derouesné, Lacomblez, Thibault, & LePoncin, 1999; Lautenschlager, Flicker, Vasikaran, Leedman, & Almeida, 2005; Sinoff & Werner, 2003). Neuroticism was a significant predictor of later SCCs in only one study reviewed here (Pearman et al., 2014), but again similar relationships have also been found in work prior to 2006 (Kliegel, Zimprich, & Eschen, 2005).

These findings suggest anxiety and neuroticism could have significant explanatory power in the relationship between SCCs and objective performance, yet have been relatively neglected in recent research. Similarly, knowledge about one's own genetic risk factors for age-related cognitive disorders such as Alzheimer's disease has previously been shown to influence both subjective and objective memory (Lineweaver, Bondi, Galasko, & Salmon, 2014; Suhr & Kinkela, 2007), although such variables were not explored in any studies that met inclusion criteria for this review. Dementia-related worry has also been shown to interact with cognitive impairment to predict SCCs (Kinzer & Suhr, 2016). Further investigation of this range of psychological variables is warranted in order to better understand the nature and extent of their role.

Constructs related to SCCs, such as memory self-efficacy (a person's beliefs about their own memory ability), are also not often examined concurrently, and may offer additional insights into the clinical utility of SCCs. For example, a recent meta-analysis found memory self-efficacy and memory performance are significantly positively correlated (Beaudoin & Desrichard, 2011), and thus investigation of the relationship between memory self-efficacy and SCCs may shed further light on both of their associations with objective performance. Compensatory strategies again offer a possible explanation here. Greater memory self-efficacy could be reasonably hypothesised to lead to increased employment of compensatory strategies, which in turn might lead to better memory performance as well as fewer ongoing SCCs.

Suggestions for Future Research

In agreement with Jonker et al. (2000) and Reid and MacLullich (2006), there is still evidence that inconsistency and lack of validation among assessment procedures used among studies influences the results obtained. Consequently, explicit investigation of how these different procedures (e.g., single yes/no questions vs. multiple questions vs. questionnaires) influence SCC reports would be of great value (see Burmester, Leathem, & Merrick, 2015 for a recent exploration of this question). Similarly, further investigation or explicit review of informant reports as indicators of cognitive impairment could be valuable, as only a subset of those studies which have assessed informant reports happened to meet the inclusion criteria for this review. Further, the development of a “gold standard” measure (as noted by Rabin et al., 2015) for assessing SCCs would also be helpful in establishing some consistency across studies.

Following this progress, further analysis of the links between SCCs and objective performance among differing populations could be assessed more robustly, and the influence of psychological variables better understood. In particular, the role of depressive symptoms appears to be of greatest importance and warrants further investigation, as does that of anxiety, demographic variables and informant reports. Finally, refinement of the procedures used to assess objective performance would be advantageous due to the wide variation noted here, especially comparing the relationships between SCCs and various measures of objective performance.

Direct investigation of the compensation aetiology of SCCs as proposed here is necessary. This could initially consist of assessment of SCCs, objective performance, executive functioning and compensatory strategies in a within-subjects design. Measures of compensatory strategies such as the Memory Compensation Questionnaire (Dixon, de Frias, & Bäckman, 2001) could be valuable here, as well as SCC measures in which participants are prompted to distinguish between memory difficulties for which they have effective compensatory strategies and those which still cause functional impairment. The compensation theory of SCCs predicts that executive functioning measures would mediate the relationship between SCCs and objective performance, with lower numbers of SCCs being related to greater executive functioning abilities (and effective use of compensatory strategies) and lower rates of objective performance. Investigations of such hypotheses are also warranted.

Clinical Implications

The primary point of relevance for clinical practice offered by this review is that the value of SCCs for indicating objectively detectable cognitive impairment is very small at best. Clinicians are advised that depressive symptoms are more likely to be related to SCCs than actual impairment, and further investigations should proceed as such. However in doing so, we stress the importance of validating patients' concerns without dismissing SCCs as solely mood-related symptoms. Instead, it is recommended that the limited link between SCCs and actual performance is discussed with a concurrent emphasis on developing compensatory strategies that are effective for the difficulties experienced, regardless of their aetiology.

One primary explanation for the varying results reviewed here related to the impact of SCC assessments on the results obtained. Consequently, clinicians should be aware of how their chosen method of assessing SCCs might influence the reports gathered (at least until progress is made towards establishing a 'gold standard' measure as mentioned above). In particular, single question assessments requiring only a yes/no response (e.g., “Do you have problems with your memory?”) were alarmingly common, and associated with greater influences of confounding variables such as affective aetiologies. If such questions continue to be used in practice, it is recommended that at most they function only as a screen for more detailed assessment, much in the manner of screens for objective cognitive functioning such as the MMSE. More detailed methods are recommended for clinical use in order to better understand which SCCs which are most salient for an individual and what possible aetiologies different SCCs might be associated with. Open-ended, non-prescriptive questions are also recommended because the internal nature of SCCs means they are likely to be best reflected when descriptions are generated by the individual themselves rather than responding to a pre-conceived set of particular questions (see also Burmester et al., 2015).

The compensation theory of SCCs proposed here suggests that clinical assessments would also be well advised to include measures of both the presence of various SCCs as well as their functional impact. This distinction would allow clinicians to target SCCs with the most distressing functional consequences and assess the presence of SCCs that may have little functional impact due to use of effective compensation strategies.

Limitations

The findings of this review are subject to limitations. These include questions about the external validity of findings – given that only 50 articles of 2221 initial search results met inclusion criteria, there might be limits to the degree to which findings can be generalised to the full domain. However, we would argue that this pattern reflects the broad search terms used initially, meaning that approximately three-quarters of the initial articles were either duplicates or did not actually examine the topic of interest. The advantage of using broad initial search strategies also meant that relevant articles were less likely to be missed.

Secondly, the construct of SCCs has previously been described by other terms (e.g., meta-memory, subjective memory complaints, memory self-efficacy, memory beliefs, forgetfulness, everyday memory failures), which may have meant relevant articles that used these terms were not included in the review. However, SCCs is the predominant term for this phenomenon and is that which is associated with diagnostic criteria for MCI (American Psychological Association, 2013). Other expressions usually refer to conceptually related, but different, phenomena, and thus inclusion of these terms would have conflated SCCs with other constructs and posed a greater threat to internal validity.

As with any review, publication bias influences which findings are available for inclusion. Here, results indicated some potential influence of publication bias, however the high degree of heterogeneity observed means that estimates of publication bias are of limited accuracy. It is also noted that, in this topic area, the abundance of mixed results could be an indicator that the ‘file-drawer’ problem may have less influence than in other fields in which published findings are dominated by significant effects.

The existing wide heterogeneity among studies, inconsistency of results in this area, and considerable variation in the measures of SCCs, objective performance, confounding factors, and in the samples used (with varying exclusion criteria) also contributed to the caution with which conclusions can be drawn. Give that the current status of this field is characterised by highly mixed findings, the causes of which are not understood, combining results in a meta-analysis might obscure important factors and thus more detailed examinations of the particular methodological factors outlined earlier are warranted in order to first produce more homogeneous studies and disentangle the roles of the numerous moderating variables identified here.

Conclusions

Since 2006, cross-sectional studies examining the link between SCCs and objective performance suggest that this association is significant but small, and likely of less importance than that between SCCs and affective symptoms. Future research that clarifies the influence of assessment methods on the results obtained is likely to be of great value in understanding the nature of how SCCs reflect current or future cognitive impairments. One possible explanation of the mixed findings across studies may be that SCCs reflect only difficulties which have not been successfully ameliorated through compensation strategies, and thus further investigation of this theory is also warranted.

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CHAPTER 2

THEORIES OF COGNITIVE AGEING

Introduction

The ultimate aim of this chapter is to identify how mechanisms of age-related cognitive change may underlie the development of SCCs. First, patterns of age-related change are summarised for a range of cognitive domains, with a specific focus on various types of memory functioning. Next, theories of cognitive ageing used to explain these age-related declines are reviewed. Finally, possible links between these theories of cognitive ageing and subjective cognitive functioning are discussed.

Patterns of Cognitive Ageing

The most general trend observed in cognitive ageing is the decline with age of fluid cognitive abilities (such as reasoning, problem-solving, and cognitive speed) and patterns of increase or relative stability in crystallised abilities such as vocabulary (Alwin, 2009; Schaie, Willis, & Caskie, 2004). Fluid abilities reflect ongoing capacities to process information and may begin a linear pattern of decline as early as the third decade of life, whereas crystallised abilities generally describe the products of such processing, may not show signs of decline until age 70 or beyond (Salthouse, 2010), and tend to decline less severely than fluid abilities. Of the fluid abilities, processing speed begins to decline the earliest (Schaie et al., 2004) and often explains significant amounts of decline in other abilities, leading to its hypothesised position as a key mechanism of cognitive ageing (Salthouse, 2010).

Memory

Within memory abilities specifically, there are noted dissociations between the ageing of different faculties. Figure 5 shows a common conceptualisation of different types of memory, and their general patterns of change with age. At the broadest level, all three main memory systems display decline in at least some areas. The first type of memory store often proposed is sensory memory, which refers to the very early traces of modality-specific information (Atkinson & Shiffrin, 1968). This type of memory is necessarily subject to any age-related declines in sensory systems (Craik, 2000), however the limited evidence available

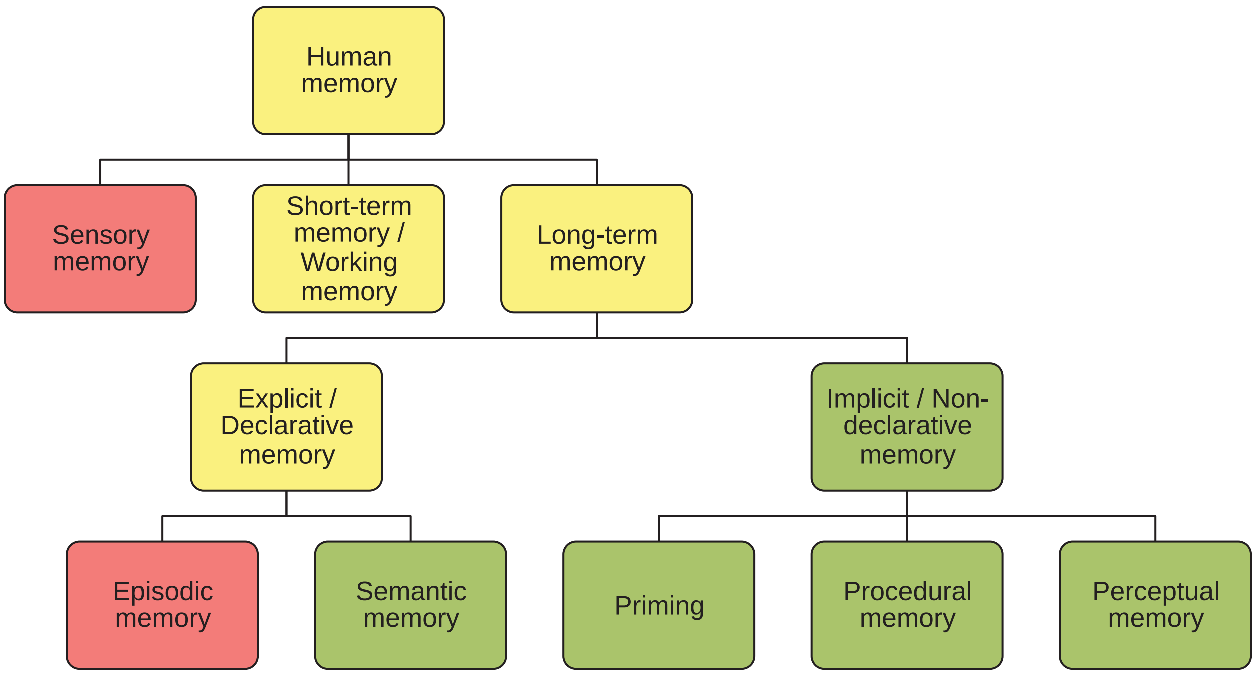

Figure 5. Patterns of age-related change in different types of memory.
Note. Red boxes denote memory systems that display general patterns of decline with age; green denotes those that remain stable or increase with age; yellow boxes denote systems with mixed patterns of age-related change.

does suggest that memory for sensory information remains intact with age (Balota, Dolan, & Duchek, 2000). Secondly, short-term memory describes the practice of maintaining conscious awareness of small amounts of information for a limited time (with working memory being the active manipulation of such information; Craik, 2000). Old and Naveh-Benjamin (2008) summarise the effect of age on this system as relatively minor (or absent) for short-term memory tasks which require little active manipulation, whereas more cognitively demanding working memory tasks do display greater rates of age-related decline. Indeed older adults do commonly report difficulties of remembering information ‘from one second to the next’ (Amariglio, Townsend, Grodstein, Sperling, & Rentz, 2011), which would apparently indicate short-term and/or working memory difficulties.

Long-term memory is commonly divided into two major types depending on whether memory is demonstrated through conscious recollection (explicit or declarative memory) or changes in behaviour below the threshold of awareness (implicit or non-declarative memory). Within explicit memory, a further division into memory for autobiographically specific events (episodic memory) and factual information (semantic memory) is supported by differing patterns of age-related change. Episodic memory displays one of the most severe declines with age, and also corresponds to a wide range of common SCCs, such as recalling details of a recent event (Craik, 2000). This decline also varies as a function of the level of environmental support given during recall, with the most pronounced difficulties occurring on tests of free recall, whereas the provision of recall cues or recognition tests elicit relatively improved performance (Old & Naveh-Benjamin, 2008). Age-related deficits for particular aspects of episodic memory are also apparent, with older adults displaying particular difficulties in recalling contextual details of an event (such as when and where it occurred; Old & Naveh-Benjamin, 2008) and in forming and using links between multiple aspects of a memory (such as recalling a person's name and where they are known from; Craik, 2000).

By contrast, semantic memory shows little decline with age for previously established facts, with older adults generally performing at least as well as younger adults on tests of general knowledge and vocabulary (Balota et al., 2000). However, the ability to establish new semantic memories (i.e., learn new facts) is often more difficult with age (Old & Naveh-Benjamin, 2008). Craik (2000) notes that SCCs related to word-finding difficulties and memory for people's names would appear to reflect difficulties of semantic memory, and these are known to increase with age. One explanation for this discrepancy is that these types of SCCs (as well as episodic memory difficulties) reflect recall of highly specific information that has only isolated links to other knowledge, whereas other types of information in semantic memory (e.g., objective facts) can be expressed in multiple ways and therefore be accessed more easily (Craik, 2000). Alternatively, word-finding difficulties may represent a specific difficulty in accessing the phonological codes necessary to articulate a word (Balota et al., 2000).

Implicit memory generally shows few detrimental effects of age, as demonstrated via a variety of methods. Older adults show similar or better performance to younger adults on semantic priming tasks, even when their explicit recall of the primed stimuli is relatively impaired (Laver & Burke, 1993; Mitchell, 1989). Procedural memory is commonly demonstrated through the ability to perform previously learned tasks and does not show evidence of decline with age (Balota et al., 2000), nor is it reflected in common SCCs (Apolinario et al., 2012). Preservation of implicit memory faculties is also demonstrated through the dissociation between explicit recollection of stimuli (which declines with age) and the ability to report ‘familiarity’ of stimuli in the absence of conscious recollection (which remains stable with age; Old & Naveh-Benjamin, 2008). This pattern can lead to increased susceptibility to interference in memory, as well as the generation of false memories (Craik, 2000).

Spatial memory spans across the division of memory into sensory, short-term, and long-term stores, and describes memory for visually and topographically organised information about the environment (Schacter & Nadel, 1991). Spatial memory declines markedly with age and may be linked to age-related difficulties in recalling contextual information or integrity of visual systems (Craik, 2000). Alternatively, impairment on tests of spatial memory may reflect difficulty translating spatial knowledge into explicit recall (e.g., describing the layout of a town), whereas implicit use of this information (e.g., finding one’s way around the town) remains intact with age (Craik, 2000).

Prospective memory (the ability to recall upcoming future events) is another type of memory which can decline with age - although this effect tends to be limited to laboratory-based tasks and also varies according to the presence of reminder cues and the exact nature of the task (Anderson & Craik, 2000; Salthouse, 2010). Older adults also show a memory benefit for information with positive emotional valence, whereas no such difference is shown in younger adults (Old & Naveh-Benjamin, 2008).

Theories of Cognitive Ageing

Attempts to explain the above patterns observed in cognitive ageing have resulted in a large number of proposed underlying mechanisms. Before discussing these in detail (page 63 onwards), important qualities of all cognitive ageing theories are summarised here.

While most studies of cognitive ageing have focused on comparisons between groups of younger adults (often aged 18-40) and older adults (aged 65 and over), Willis, Martin, and Rocke (2010) highlight the need to also consider patterns of performance among adults in midlife (ages 40-65). While midlife appears to be characterised by relative stability of cognitive abilities (Lachman, 2004), this can be an artefact of the averaging of all abilities, when in fact cognitive abilities diverge dramatically during midlife (Schroeder & Salthouse, 2004; Willis & Schaie, 2005). In particular, delayed recall performance is most susceptible to change during midlife, and along with immediate recall, verbal fluency, and processing speed, is a significant predictor of cognitive impairment in older adulthood (Willis & Schaie, 2005).

Another important point to note about patterns of cognitive ageing is the relatively small associations between decline evident on neuropsychological tests, and performance on functional measures of cognitive ability (Bosworth & Ayotte, 2009). Salthouse (2010) presents four reasons that may underlie this discrepancy. Firstly, everyday functioning reflects typical levels of activity and performance, whereas results of cognitive tests reflect maximal levels, and so cognitive decline reflects a lowering of one’s ceiling level of performance (although this is rarely reached in everyday activities). Secondly, everyday functioning makes greater use of crystallised knowledge such as facts and habits, whereas cognitive declines are often concentrated in fluid abilities. Third, the influence of other factors such as personality and motivation may account for some of the discrepancy between functional success and cognitive performance. Finally, cognitive declines may in fact have functional consequences, but these are effectively reduced or disguised by compensatory strategies.

Theories of cognitive ageing also need to consider the type of evidence used to evaluate them. Broadly, cross-sectional studies are vulnerable to cohort effects where findings are specific to the particular generation of participants, whereas retest and maturation effects can introduce error into longitudinal study designs and may disguise evidence of cognitive decline. Salthouse (2009) analysed the relative contributions of these effects to the conclusions drawn about cognitive ageing, and found that while both designs were subject to various effects, retest effects were often larger than cohort effects. Consequently, longitudinal designs, while valuable for examining within-subject changes, are also likely to underestimate age-related change in many cognitive variables. Salthouse (2010) recommends the initial use of cross-sectional designs to explore new ideas and later gathering longitudinal evidence once theories have been refined.

A number of possible mechanisms that underlie multiple patterns observed in cognitive ageing have been proposed, and will be discussed here in two main categories. First, the historically dominant processing speed theory of cognitive ageing will be summarised. This theory concerns the influence of cognitive processing speed and its role in explaining decline in many other cognitive functions such as working memory, sensory abilities, and compensation for cognitive decline. Second, theories that broadly relate to executive functioning abilities, including those based on constructs of inhibition, attention, and frontal lobe functioning, will be presented and evaluated. Later, the value of each type of theory will be assessed in relation to subjective measures of cognition, in preparation for empirical study of the aetiological contribution of each construct to explaining SCCs.

Processing Speed Theory

Processing speed refers to how quickly an individual can comprehend and use incoming information (Salthouse, 1992), and is implicated in almost all higher cognitive functions such as problem solving, planning, organisation, and integration of information (Groth-Marnat, 2009). Processing speed is one of the cognitive faculties most sensitive to any kind of objective impairment (Groth-Marnat, 2009), and is the first to begin to decline with age (Schaie, 1994). Changes in processing speed are also associated with the onset of functional difficulties in daily living (Lin, Chen, Vance, & Mapstone, 2013; Wahl, Schmitt, Danner, & Coppin, 2010), suggesting that this construct may also be particularly related to subjective perceptions of performance.

A well-established theory of cognitive ageing championed by Salthouse (1996a; 2000a) asserts that a general slowing in processing speed likely underlies much of the age-related decline in most other cognitive functions. Support for this hypothesis has been repeatedly demonstrated via a variety of methodological techniques. Firstly, statistical control of scores on processing speed measures often attenuates any link between age and cognitive performance by 90% or more (Salthouse, 1993). Secondly, modelling the relationship among processing speed, age, and cognitive variables is most parsimoniously done when conceptualising speed as a single common factor across all processing speed tasks (Salthouse, 1996b). Any remaining effects that are specific to unique measures of processing speed are very small (Salthouse, 1996b). Thirdly, recent meta-analyses of evidence regarding processing speed theory has shown that the explanatory power of processing speed for cognitive ageing is not attributable to cohort effects or validity and reliability of the particular measures used (Verhaeghen, 2014), nor is it due to the confounding variable of motor speed (Salthouse, 1993; 1994). Fourth, in longitudinal studies, processing speed explains the largest proportion of variance in later cognitive functioning after that predicted by earlier performance (Deary, Johnson, & Starr, 2010; Nettelbeck & Rabbitt, 1992). Finally, work comparing the performance of older adults with and without dementia diagnoses found significant differences in the predictive power of processing speed for later memory performance, suggesting that processing speed represents a component underlying processes of normal cognitive ageing rather than disease-specific patterns (Sliwinski & Buschke, 1997).

Processing speed effectively functions as a mediator of the relationship between age and memory performance (Finkel, Reynolds, McArdle, & Pedersen, 2007; Verhaeghen, 2014).

Further support for the processing speed theory of cognitive ageing has been produced by studies aiming to compare the value of processing speed with that of other proposed explanatory constructs. For example, processing speed mediates the relationship between age and working memory ability to a similar degree as it does for other cognitive abilities (Salthouse, 1992), and working memory offers little unique predictive value beyond that already explained by processing speed (Verhaeghen & Salthouse, 1997). There is a lack of robust evidence to support a working memory theory of cognitive ageing, regardless of whether the construct is formulated as a decline in capacity, manipulation ability, or information coordination (Salthouse, 1991).

Other constructs that have been proposed as potential mechanisms of cognitive ageing include the degradation of sensory abilities with age (Baltes & Lindenberger, 1997), motivation (Salthouse, 1996c), and education (Bryan, Luszcz, & Crawford, 1997). However, various authors discount these theories in favour of processing speed. For example, Hartley (2006) and Hoyer and Verhaeghen (2006) note that the observed positive relationship between task complexity and age-related decline would not be predicted by models which focused on sensory abilities, and that degrading sensory input for younger adults does not simulate the relative decline shown in older adults. Salthouse (1993) also found that processing speed measures that are specific to the execution of cognitive operations, rather than sensory or motor ones, explained age-related differences in cognition. Factors of motivation and education are not related to age-related patterns of change in cognitive variables (Salthouse, 2011; Sliwinski & Buschke, 1997).

Executive Function Theory

A second group of theories of cognitive ageing broadly relate to higher-order executive function abilities. Such hypotheses tend to be interrelated and overlapping due to the ill-defined nature of executive function as a construct. However, Salthouse, Atkinson, and Berish (2003) found moderate support for the validity of executive functioning as a single construct (through convergent validity and factor loadings), as well as for more specific aspects of working memory, inhibition, and attention. Other work suggests that specific measures of particular aspects of executive function may hold relatively unique predictive value - for example, verbal fluency as an indicator of global executive function declines, and Stroop tasks as measures of inhibition (Kemper & McDowd, 2008). Age-related declines in executive functions may also act alongside other mechanisms such as processing speed (De Luca & Leventer, 2008). Executive function theories of cognitive ageing can be broadly categorised into three constructs.

First, an early conceptualisation of executive abilities as ‘processing resources’ (Craik & Byrd, 1982) relates to both the mental energy and attentional resources which enable task performance. McDaniel, Einstein, and Jacoby (2008) propose that as sensory processes decline with age, greater proportions of these resources are needed to overcome sensory deficits and so fewer resources are available for cognitive processing. Age-related decline in processing resources is consistent with evidence of exaggerated effects when older adults’ attention is divided between tasks, and when tasks have more extensive processing requirements (e.g., involve novel or unfamiliar material; Rabinowitz, Craik, & Ackerman, 1982). However, Rogers (2000) highlights that these effects diminish with practice, and instead suggest that patterns of performance might be better explained via other mechanisms.

One such mechanism is inhibition, a construct that characterises a second major theory of cognitive ageing. Under this model, inhibition acts as a gatekeeper for working memory, ensuring that only relevant information is active during a task (Hasher & Zacks, 1988). The proposal that inhibition processes decline in effectiveness with age predicts greater difficulty for older adults on tasks that involve switching attention, ignoring distractions, and maintaining multiple relevant pieces of information simultaneously (Anderson & Craik, 2000;

Hasher, Tonev, Lustig, & Zacks, 2001). Functionally, these difficulties can manifest as behaviours which are known to be more common in older than younger adults, such as distractibility, forgetfulness, and delayed or inappropriate responses (Hasher & Zacks, 1988). While evidence for inhibition theory has been somewhat mixed, this may reflect the changing role of inhibition depending on the particular processing stage and the specific task requirements (McDowd, 2001; McDowd & Hoffman, 2008). Maylor, Schlaghecken, and Watson (2005) summarised alternative explanations of the inhibition hypothesis, such as general slowing of processing speed and perceptual limitations, however concluded that the evidence favours inhibition theory when restricted to those functions which rely on the integrity of frontal lobe brain structures.

The third and final theory of cognitive ageing to be discussed here is based on anatomical rather than theoretical constructs, and is referred to here as the frontal lobe hypothesis. Originally outlined by West (1996), this idea stems from the observation that patterns of cognitive ageing are consistent with declines in processes supported by the frontal lobes. As well as inhibition, other executive functions such as goal maintenance, cognitive control, and coordination are implicated (Braver & West, 2008). Neuroanatomically, the frontal lobe hypothesis is supported by positive relationships between age and neuronal atrophy, synapse loss, reduced oxygen uptake and decreased brain volume in the frontal lobes especially (West, 1996). Also consistent with the frontal lobe hypothesis is evidence that older adults show patterns of change similar to those in patients with damage to the frontal lobes (Braver & West, 2008).

Luszcz (2011) conceptualises the primary function of frontal lobe-based executive function as controlled processing, and cites supporting evidence from neuroimaging studies that older adults recruit frontal areas even when tasks do not necessarily require it (whereas younger adults only employ frontal/executive function areas when necessary). One explanation for apparently unnecessary recruitment of frontal structures (and executive function abilities) is that older adults need to employ compensatory strategies to a greater extent than younger adults, even for somewhat simpler tasks (Phillips & Henry, 2008). This compensation explanation is also consistent with greater effects of age-related decline for more complex tasks (West & Bowry, 2005) and less functional impact for slower rates of decline (Phillips & Henry, 2008).

A seemingly contrary pattern of activation has been shown for memory tasks specifically, whereby older adults demonstrate under-recruitment of frontal areas (Buckner, 2004). However, this may still be consistent with compensation interpretations if such tasks represent deficits that are not effectively compensated for and which therefore persist as subjective and/or functional difficulties. Further support for this explanation is offered by evidence that providing compensation on these tasks through increased environmental support or contextual cues increases the recruitment of frontal areas (Buckner, 2004; Glisky, 2001), and that older adults with clinical diagnoses of MCI show less employment of compensatory mechanisms (Doi et al., 2013).

Overall, theories based on executive functioning offer overlapping but incomplete explanations for the patterns of performance observed in cognitive ageing. One method of reconciling these discrepancies is through approaching all theories of cognitive ageing as complementary rather than mutually exclusive explanations.

Combining Theories of Cognitive Ageing

Research examining the comparative explanatory power of the various theories of cognitive ageing generally offers substantial support for Salthouse’s processing speed theory, but evidence for the role of executive function processes is also increasing. Processing speed has often been found to explain substantial proportions (if not all) of the variance in other proposed constructs such as working memory, inhibition, and divided attention (Park & Hedden, 2001; Salthouse, 1991; 2000b; Smith, Petersen, Ivnik, Malec, & Tangalos, 1996), suggesting that processing speed is the key explanatory factor in understanding cognitive ageing.

However, more recent evidence suggests that patterns of age-related cognitive change might be better explained by a combination of processing speed and executive function factors. For example, Albinet, Boucard, Bouquet, and Audiffren (2012) compared the performance of younger and older adults on various measures of executive function and processing speed, and found unique contributions of both constructs in explaining age-related effects on performance across the measures. Scores on processing speed measures accounted for 85% of the age-related variance in executive function measures, however there was still a small but important component of this variance uniquely attributed to age, and thus the best explanation of cognitive ageing made use of both processing speed and executive function theories in combination.

Previously, Baudouin, Clarys, Vanneste, and Isingrini (2009) had reached a similar conclusion from complementary results, whereby statistical control of executive functioning scores offered the greatest attenuation of age-related variance in episodic memory scores, however a unique contribution was also made by processing speed scores. Similarly, De Luca and Leventer (2008) summarised research showing that slowed processing speed alone is not sufficient to explain all age-related cognitive declines, and that both speed and executive components are necessary to explain them.

Such findings highlight the importance of considering multiple explanatory factors of cognitive ageing, despite sometimes large contributions of single constructs to age-related variance in performance.

Subjective Cognitive Complaints and Theories of Cognitive Ageing

The relationship between cognitive ageing mechanisms and subjective reports of cognitive functioning has not been extensively researched. Given the variability in results regarding subjective and objective measures of memory changes with age (Chapter 1), and the power of cognitive ageing theories to explain changes in objective functioning, examination of the role of cognitive ageing mechanisms in explaining SCCs is warranted. Evidence for links between proposed mechanisms such as processing speed or executive functioning abilities and SCCs would provide further understanding of both cognitive ageing and SCC aetiologies. Findings in this area to date suggest that both categories of cognitive ageing mechanisms (i.e., processing speed and executive function) could explain SCCs to some degree. The research discussed here includes both measures of SCCs and functional activity as indicators of subjective performance due to the limited literature examining SCCs alone, although it is noted that functional measures likely reflect a more objective indicator of performance than do explicit self-reports of functioning.

Regarding processing speed, Mol, van Boxtel, Willems, and Jolles (2006) found that SCCs were cross-sectionally associated with lower scores on a measure of processing speed, and Wahl et al. (2010) found that longitudinal decline in functional impairment was associated with slower processing speed. Lin et al. (2013) also found support for processing speed as a mediator of functional declines with age. They assessed processing speed in both laboratory and real-world contexts, and found that participants who were the most likely to display functional decline over time tended to have lower processing speed scores (in both contexts) at baseline, and experience greater rates of decline in processing speed over time. By contrast, other studies have found that processing speed scores did not differ between participants with functionally significant SCCs and healthy controls (Metternich, Schmidtke, & Hüll, 2009; Schmidtke, Pohlmann, & Metternich, 2008). However, these results may reflect the choice of using the Trail Making Test (Reitan, 1958) as a measure of processing speed, whereas other studies (e.g., Fonseca et al., 2015; Gavett, Dunn, Stoddard, Harty, & Weintraub, 2011) have employed it as a measure of attentional and/or executive functioning abilities instead. In general, processing speed is more commonly assessed via measures such as the digit symbol substitution test (e.g., Wahl et al., 2010), or letter digit sequencing (e.g., Mol et al., 2006).

Executive functioning abilities may also hold promise in explaining the aetiology of SCCs. For example, lowered inhibition is associated with more SCCs (Potter & Hartman, 2006), suggesting that at least some SCCs may reflect difficulty inhibiting irrelevant interfering information. Similarly, SCCs may result from difficulties in selective attention (Gavett et al., 2011; McDowd & Hoffman, 2008; Plude, Schwartz, & Murphy, 1996). Rouch et al. (2008) also found scores on executive function measures were inversely related to SCCs, and Fonseca et al. (2015) found that executive function scores (assessed with the Trail Making Test) in participants with SCCs were lower for participants who later experienced cognitive decline than for those who did not decline. Executive functioning components such as problem solving and integration of internal knowledge with external stimuli presumably underlie the ability to effectively compensate for declines in other cognitive functions, and thus would be associated with SCCs where they describe difficulties for which an effective compensatory strategy has not been found (Bosworth & Ayotte, 2009; Hasher & Zacks, 1988; Hertzog, 2008; Salthouse, 2011).

Summary

Almost all cognitive abilities display patterns of age-related change. Fluid abilities such as problem solving, reasoning, and speed tend to decline, while crystallised abilities such as vocabulary remain stable or improve even into older adulthood. Within memory abilities, age-related declines are evident in sensory memory (as a result of decline in sensory abilities) and episodic memory, while semantic memory and all types of implicit memory are relatively robust to decline.

Theories of cognitive ageing attempt to parsimoniously explain these patterns of change with small numbers of key factors. In particular, processing speed and executive function theories assert that these factors can explain much of the age-related variance in a wide range of cognitive abilities. While established evidence exists for both theories, recent work suggests that the most applicable explanation for cognitive ageing may incorporate both processing speed and executive function components in a complementary manner.

Evidence for the power of cognitive ageing theories to explain subjective and functional perceptions of cognitive ageing is less extensive, however there are suggestions to this effect. Specifically, processing speed mediates the relationship between age and functional declines (Lin et al., 2013), and executive functioning abilities including inhibition and selective attention are associated with SCCs (McDowd & Hoffman, 2008; Potter & Hartman, 2006; Rouch et al., 2008) as well as success in compensating effectively for any difficulties (Bosworth & Ayotte, 2009; Salthouse, 2011). These results suggest that both processing speed and executive functioning constructs warrant inclusion in any future studies of the relationship between SCCs and cognitive functioning.

CHAPTER 3

SUBJECTIVE COGNITIVE COMPLAINTS AND PSYCHOLOGICAL, DEMOGRAPHIC AND ASSESSMENT FACTORS

Introduction

A number of factors that modify the relationship between SCCs and objective memory performance have been identified in literature to date. Some of these, such as depressive symptoms, were mentioned in Chapter 1 and will be discussed in greater depth here, along with other psychological, demographic, and methodological factors. The aim of this chapter is to review findings concerning these modifying variables, in order to inform hypotheses about which of them are expected to carry most weight in explaining the aetiology of SCCs (and thus warrant inclusion in the research).

Psychological Variables

Depression

Depressive symptoms are perhaps the most widely examined of these moderating variables, and warranted extensive exploration in previous reviews (Jonker, Geerlings, & Schmand, 2000; Reid & MacLullich, 2006; Burmester, Leathem, & Merrick, 2016). Many researchers have suggested that depressive symptoms are in fact the primary aetiological underpinning of SCCs, based on evidence that scores on depression inventories positively predict the quantity and/or severity of SCCs where scores on memory tests offer less predictive value (Benito-León, Mitchell, Vega, & Bermejo-Pareja, 2010; Gates, Valenzuela, Sachdev, & Singh, 2014; Rickenbach, Agrigoroaei, & Lachman, 2015; Rönnlund, Vestergren, Mäntylä, & Nilsson, 2011; Salem, Vogel, Ebstrup, Linneberg, & Waldemar, 2015; Slavin et al., 2010; Sohrabi et al., 2009; Yates, Clare, & Woods, 2015). Similarly, Balash et al. (2013) and Metternich, Schmidtke, and Hüll (2009) found that the presence of SCCs in the absence of cognitive impairment (a condition which Metternich et al., 2009, label *functional memory disorder*) is characterised by elevated scores on depression measures. However, such findings exist in opposition to other conclusions that depressive symptoms offer little to no predictive value for SCCs over and above that already provided by measures of objective memory performance (Auw & Lum, 2013; Cook & Marsiske, 2006; Sims et al., 2011), or that both actual memory performance and depressive symptoms offer unique contributions to the explanation of SCCs (Jorm et al., 2004; Langlois & Belleville, 2014; Lehrner et al., 2014; Merema, Speelman, Foster, & Kaczmarek, 2013; Rouch et al., 2008; Snitz, Morrow, Rodriguez, Huber, & Saxton, 2008). Also frequently highlighted is the observation that depressive symptoms are associated with SCCs even at sub-clinical levels or when participants with diagnosed depressive disorders are excluded from analyses (Crumley, Stetler, & Horhota, 2014; Levy-Cushraan & Abeles, 1998; Reid & MacLullich, 2006; Steinberg et al., 2013).

Possible explanations for these mixed findings have been suggested and are yet to be disentangled entirely. Tomita et al. (2014) found that depressive symptoms were associated with SCCs in women, whereas in men they were related to objective memory impairment, suggesting that the aetiology of SCCs can differ by gender. Other researchers suggest that affective explanations of SCCs might operate differently in different age groups – for example, Shmotkin et al. (2013) found an association between fewer SCCs and more depressive symptoms in participants aged 87 and older, which they interpreted as a potential indicator of psychological defence mechanisms that offer positive evaluations of memory in the service of self-image preservation. SCCs may reflect depressive/affective aetiologies more so for younger participants, whereas SCCs of older participants are more strongly linked to actual performance (Buckley et al., 2013; Jonker et al., 2000; Kliegel, Zimprich, & Eschen, 2005; Weaver Cargin, Collie, Masters, & Maruff, 2008).

The mechanism which links depressive symptoms and SCCs could be that the negative cognitive bias associated with depressive symptoms triggers negative evaluations of one's memory abilities (Chin, Oh, Seo, & Na, 2014; Crane, Bogner, Brown, & Gallo, 2007; Hülür, Hertzog, Pearman, Ram, & Gerstorf, 2014; Jorm, 2001; Jorm et al., 2004; Langlois & Belleville, 2014; Mascherek, Zimprich, Rupprecht, & Lang, 2011; Mendes et al., 2008; Montejo et al., 2014; Ponds, van Boxtel, & Jolles, 2000; Potter & Hartman, 2006).

Alternatively, memory difficulties could be a direct symptom of depression (Bolla, Lindgren, Bonaccorsy, & Bleecker, 1991; Langlois & Belleville, 2014; Montejo et al., 2014), or age-related declines in performance could trigger both SCCs and depressive symptoms (Chin et al., 2014; Jorm, 2001). Zimprich, Martin, and Kliegel (2003) examined the relationships between depression, SCCs and memory performance with structural equation modelling and concluded that low associations between SCCs and memory performance are likely due to a combination of the mediating effect of depression, as well as methodological issues in the measurement of SCCs and memory performance (methodological issues are discussed in more depth on page 83). Finally, Glodzik-Sobanska et al. (2007) examined 'unstable' trajectories of cognitive change with age in comparison to 'declining' and 'non-declining' groups, and suggest that the mixed results of other studies may be due to their conflation of unstable and declining trajectories, whereas depressive symptoms are selectively linked to unstable trajectories rather than steady cognitive decline.

Anxiety

Although anxiety also represents a state of negative affect and is often related to depression, it has been relatively less studied in relation to the link between SCCs and memory performance. Nevertheless, earlier work by Bassett and Folstein (1993) found that SCCs were significantly associated with anxiety disorders, and later research has also produced similar results (Balash et al., 2013; Clarnette, Almeida, Forstl, Paton, & Martins, 2001; Jorm et al., 2004; Jorm, Christensen, Korten, Jacomb, & Henderson, 2001; Montejo, Montenegro, Fernández, & Maestú, 2011; Reid et al., 2012; Rouch et al., 2008; Slavin et al., 2010).

Like depressive symptoms, SCCs can also be an indicator of anxiety symptoms rather than actual cognitive performance or decline (Bassett & Folstein, 1993; Buckley et al., 2013; Slavin et al., 2010; Weaver Cargin et al., 2008). However despite the close relationship between depression and anxiety, anxiety does explain unique proportions of the variance in

SCCs (Potter & Hartman, 2006) and some aspects of cognitive performance (Rouch et al., 2008). Sinoff and Werner (2003) found that while SCCs were correlated with depressive symptoms, it was in fact anxiety that influenced decline in objective cognitive functioning (both directly, and indirectly via depressive symptoms). Consequently, they concluded that anxiety was the key predictor of future cognitive decline, with SCCs being related to anxiety but not predictive of objective decline.

A number of studies have also noted a possible age-specific relationship between anxiety and SCCs. For example, Derouesné, Lacomblez, Thibault, and LePoncin (1999) found anxiety predicted SCCs in participants aged 50 and above but not in those aged below 50. Weaver Cargin et al. (2008) found SCCs of participants aged 50-60 were related to affective symptoms (including anxiety), while those in older participants were instead more indicative of actual performance.

Various mechanisms by which anxiety might explain SCCs have been proposed. Principally, anxiety is thought to increase both attention to, and negative evaluations of, one's performance - independently of actual performance (Jorm et al., 2001; 2004; Potter & Hartman, 2006; Reid et al., 2012). Alternatively, anxiety may trigger SCCs indirectly by interfering with optimal memory performance (Jorm et al., 2001), or SCCs may indicate a predisposition to anxiety (Broadbent, Cooper, Fitzgerald, & Parkes, 1982; Wilkes, Wilson, Woodard, & Calamari, 2013). Elfgren, Gustafson, Vestberg, and Passant (2010) suggest that volunteer samples exhibit a relationship between SCCs and anxiety because anxiety prompts these participants to seek help for their SCCs. Anxiety may also function as a proxy variable for certain personality traits which are related to SCCs (Sohrabi et al., 2009).

Personality

Personality factors most widely studied in relation to SCCs are those conceptualized by the Neuroticism-Extraversion-Openness Five Factor Inventory (Costa & McCrae, 1989). In particular, neuroticism is generally positively associated with SCCs (Eramudugolla, Cherbuin, Easteal, Jorm, & Anstey, 2012; Jorm et al., 2004; Kliegel et al., 2005; Metternich et al., 2009; Pearman & Storandt, 2004; Reid & MacLullich, 2006; Rickenbach et al., 2015; Slavin et al., 2010; Steinberg et al., 2013; Uttl & Kibreab, 2011). To a lesser extent, SCCs are also associated with greater conscientiousness (Pearman & Storandt, 2004; Slavin et al., 2010; Steinberg et al., 2013; Uttl & Kibreab, 2011), lower extraversion (Jorm et al., 2004; Steinberg et al., 2013), and lower openness (Slavin et al., 2010).

Pearman and Storandt (2005) broke these personality traits into more detailed facets and found that self-discipline (a facet of conscientiousness) and self-consciousness (a facet of neuroticism) were the strongest predictors of SCCs. Rönnlund et al. (2011) used another conceptualisation of personality traits and found that variance in SCCs was negatively predicted by self-directedness (a trait representing responsibility and self-acceptance, and related to negative affect). Other traits identified by van den Kommer et al. (2014) as being negatively related to SCCs included self-efficacy and a sense of mastery. Wilkes et al. (2013) proposed that trait anxiety interacted with lower cognitive functioning to produce SCCs and in turn, anxiety symptoms. Sohrabi et al. (2009) found an association between SCCs and trait (but not state) anxiety, suggesting that SCCs are related to stable anxious personality traits rather than dynamic situational anxiety.

A common interpretation of the relationship between personality and SCCs is that traits such as neuroticism create a predisposition towards negative evaluations of one’s functioning. These evaluations are then moderated by more dynamic factors such as affective symptoms to trigger SCCs (Jorm et al., 2004; Kliegel et al., 2005; Reid & MacLullich, 2006). This explanation is also supported by a finding that any variance in SCCs attributed to depression can instead be explained by neuroticism and conscientiousness (Merema et al., 2013). Neuroticism also likely contributes to SCCs through its negative relationship with actual memory functioning (Reid & MacLullich, 2006).

Other Psychological Variables

As well as affective and personality factors, SCCs have also been linked to a number of other psychological and behavioural variables.

Firstly, a poorer self-concept tends to be associated with greater rates of SCCs. For example, Pearman and Storandt (2005) found that self-esteem predicted SCCs (although this relationship was later explained via a personality mechanism of self-consciousness), and had also asserted from earlier results that memory perceptions likely depend older adults' view of themselves and might be particularly relevant in the absence of depressive symptoms (Pearman & Storandt, 2004). Similarly, Chin et al. (2014) found that self-focused attention (awareness of internally generated information) may also trigger SCCs.

Secondly, broader measures of affect and distress show similar relationships as would be expected. Smith, Petersen, Ivnik, Malec, and Tangalos (1996) found that a general measure of psychological distress predicted more variance in SCC scores than did objective measures of cognitive functioning. Paradise, Glozier, Naismith, Davenport, and Hickie (2011) and Bassett and Folstein (1993) also found psychological distress to be a major predictor of SCCs. Dux et al. (2008) and Wilkes et al. (2013) assessed negative affect with a variety of measures and found them all to be significantly related to SCCs, suggesting that high negative affect increases tendencies to complain about memory functioning, even in the absence of observable impairments. Aarts et al. (2011) found SCCs were significantly related to psychological distress, and proposed that psychological distress causes SCCs and the two together may trigger depressive symptoms.

Thirdly, general measures of wellbeing and quality of life tend to be inversely related to SCCs (Maki et al., 2014; Montejo et al., 2011; Montejo, Montenegro, Fernández, & Maestú, 2012). Mol et al. (2007) reviewed five studies concerning SCCs and quality of life, and concluded that SCCs are likely triggered by declines in quality of life rather than vice versa. Alternatively, both SCCs and lower quality of life may be a result of negative affect

(Mol et al., 2007). Similarly, various aspects of meaning in life are inversely associated with SCCs (Steinberg et al., 2013), as is general psychological wellbeing (Benito-León et al., 2010).

Fourthly, measures of life stressors show positive correlations with SCCs (Garrett, Grady, & Hasher, 2010; Steinberg et al., 2013; Vestergren & Nilsson, 2010). Metternich et al. (2009) assert that a main difference between participants with SCCs but no memory impairment and healthy controls was the level of perceived stress, which was significantly higher in the participants with SCCs. Evidence from Sims et al. (2011) showed that perceived stress predicts the level of SCCs, indicating either that SCCs are a stressor in themselves, or that stress makes perceptions of memory deficits more salient. Elfgren et al. (2010) also highlighted that high stress may prompt individuals to seek help for their SCCs, resulting in selection bias for volunteer samples. According to Garrett et al. (2010), stress is associated with SCCs because it maintains the difficulties through a lowered likelihood of compensatory behaviours. Conversely, one study found that life stressors in the last twelve months were not related to SCCs (Commissaris, Ponds, & Jolles, 1998), perhaps due to the extended timeframe applied to the stress measure in this study.

Fifthly, better physical health is also related to fewer SCCs, when assessed both by clinical diagnoses (Aarts et al., 2011) and subjective measures (Montejo et al., 2011; 2014; Ponds et al., 2000; Rickenbach et al., 2015; St John & Montgomery, 2002; Stevens, Kaplan, Ponds, & Jolles, 2001; van den Kommer et al., 2014). In fact, Stevens et al. (2001) found that *perceptions* of health and activity tended to predict SCCs even more strongly than objective measures of these factors, highlighting the real psychological consequences of negative self-perceptions. This relationship may reflect a general tendency to complain about one’s performance (Ponds et al., 2000). Similarly, better scores on functional measures of health and activity are associated with fewer SCCs (Bassett & Folstein, 1993; Benito-León et al., 2010; Eramudugolla et al., 2012; Gavett, Dunn, Stoddard, Harty, & Weintraub, 2011; Hülür et al., 2014; Montejo et al., 2011; 2012; Uttl & Kibreab, 2011).

Social support is also important to consider in relation to SCCs. Negative interpersonal relationships are positively correlated with SCCs (Steinberg et al., 2013). Greater social activity is linked to fewer SCCs (de Guzman, Lagdaan, & Lagoy, 2015), as is higher satisfaction with social support (Gates, Valenzuela, Sachdev, & Singh, 2014). Stevens et al. (2001) suggests that social support benefits cognitive functioning, which in turn reduces SCCs.

Finally, SCCs are linked to effort and compensation behaviours. For example, Armistead-Jehle, Gervais, and Green (2012) found that SCCs are inversely related to scores on measures of symptom validity, however this finding is subject to the limitation that the sample may have been motivated to perform below their ability. Gervais, Ben-Porath, Wygant, and Green (2008) also found an inverse relationship between effort and SCCs, but interpreted this as an indicator of symptom exaggeration rather than confabulation (i.e., SCCs reflect real, but minor, objective difficulties).

SCCs can be reduced directly via compensatory behaviours (e.g., writing down items to get at the supermarket) or memory aids (e.g., use of a calendar), and these tend to be used more by those with more SCCs (Garrett et al., 2010; Uttl & Kibreab, 2011). Failure to use compensatory strategies may also result in more SCCs because they make age-related declines in memory functioning more salient (Hahn & Lachman, 2015). Verhaeghen, Geraerts, and Marcoen (2000) highlight though that compensatory behaviours may not actually be prompted by SCCs in themselves, but instead by the *perception* of SCCs as more serious. Similarly, Lachman, Andreoletti, and Pearman (2006) assert that the relationship between SCCs and compensatory behaviours is mediated by a sense of control over age-related cognitive changes. Having a greater sense of control over one's own memory functioning prompts greater use of compensation and is linked to fewer SCCs (Commissaris et al., 1998; Hahn & Lachman, 2015; Sims et al., 2011; Stevens et al., 2001). These findings suggest that reporting of SCCs may be to some extent dependent on the successful use of compensatory strategies.

Summary

Various psychological variables have been linked to SCCs, the most widely examined of which is depressive symptoms. While results vary concerning the relationship between depressive symptoms and SCCs, consensus is emerging that depressive symptoms likely are a significant factor underlying the aetiology of SCCs, particularly in subgroups such as women, and both old-older adults and younger adults. The influence of depressive symptoms may also explain some degree of the varying findings between SCCs and objective cognitive performance.

Less widely studied but also related to SCCs are other psychological factors such as anxiety, as well as personality traits such as neuroticism. Both of these constructs may serve to heighten attention to one's memory and thus increase SCCs, cause SCCs by preventing optimal cognitive performance, or create selection biases for samples who are concerned about their memory. Other psychological constructs including self-esteem, general distress and wellbeing, perceived stress, physical health, social support, effort and compensatory behaviours are also correlated with SCCs in smaller numbers of studies.

Demographic Variables

Demographic factors such as age also show associations with SCCs. Not only do SCCs increase in prevalence with age (Bassett & Folstein, 1993; Ginó et al., 2010; Stevens et al., 2001), but younger people also tend to give more objectively reliable reports of their memory than older adults (Mendes et al., 2008; Merema, Speelman, Kaczmarek, & Foster, 2012). However Crumley et al. (2014) suggest that greater cognitive declines in oldest-old adults (relative to young-older adults) indicate that the relation between SCCs and memory impairments strengthens with age. As noted earlier also, SCCs may have different aetiologies depending on age. For example, middle-aged and young-older adults tend to have stronger evidence of affective aetiologies for their SCCs, whereas SCCs of older participants are more strongly linked to their actual memory performance and/or decline (Buckley et al., 2013; Jonker et al., 2000; Weaver Cargin et al., 2008). Nevertheless, some results suggest opposite relations – Hülür et al. (2014) found fewer SCCs were associated with greater age, and suggested that this may be due to differences in expectations, whereby young-old adults have higher expectations of their memory and thus more SCCs than old-older adults, who are more expectant and tolerant of memory difficulties.

Regarding gender, results differ; some showing that women tend to have more SCCs than men (e.g., Ginó et al., 2010), while others show the opposite (e.g., Stevens et al., 2001). Crumley et al. (2014) suggest that findings regarding gender differences are likely an artifact of other factors, whereby women are more influenced by other moderators of the subjective-objective memory relationship such as depressive symptoms. Ethnic differences in SCCs have not been widely studied, although there are some suggestions that the correlates of SCCs can differ as a function of ethnicity (Sims et al., 2011).

Occupation may also be related to the presence of SCCS – Schmidtke (1995) examined a group of 25 people with SCCs in the absence of memory impairment, and found they tended to be in professional employment, with a noticeable absence of manual workers. Similarly, SCCs tend to be positively correlated with education levels (Hahn & Lachman, 2015; Hülür et al., 2014), possibly because more highly educated participants are more aware of the changes in their cognition (Hahn & Lachman, 2015).

Assessment Variables

Regarding methodological factors, the nature of SCC assessment measures may influence the results generated, and thus underlie discrepant findings (Abdulrab & Heun, 2008; Apolinario et al., 2012; Vogel, Salem, Andersen & Waldemar, 2016).

SCC assessment methods can generally be divided into three types: single questions about general memory difficulties that require only a ‘yes’ or ‘no’ response (e.g., “Do you find that you have trouble with your memory?”; Bassett & Folstein, 1993); a set of similar questions that have a wider range of response options (e.g., “Do you have complaints about your memory?” - “no”, “sometimes, but is a problem”, “yes, is a problem”, or “yes, is a serious problem”; Geerlings, Jonker, Bouter, Adèr, & Schmand, 1999); and sets of questions or established questionnaire measures (Jorm et al., 2001; Smith et al., 1996).

While questionnaire methods would appear to be advantageous in that they can garner more detailed information, some research highlights important limitations. Questionnaires gather qualitatively different information than open-ended questions about SCCs, and may demonstrate a cueing effect whereby participants only mention those types of SCCs that the questionnaire prompts them to report (Apolinario et al., 2012). Chapter 5 explores this question further in a systematic within-subjects comparison of different SCC assessment measures. Further, Mattos et al. (2003) found that SCCs were not associated with memory performance when assessed via a questionnaire, yet they were when assessed via open-ended questions. This effect is examined in Chapter 6, where associations between various subjective and objective memory measures are examined.

Conclusion

A number of psychological and behavioural variables appear to moderate the relationship between subjective and objective memory, although often there are a number of potential explanations for how these factors have an effect. Depressive symptoms appear to be strongly related to SCCs, and may underlie them in some populations, but it is not clear whether they are generally a cause or result of SCCs, or a mutual effect of ageing. Anxiety is also related to SCCs and may predict unique aspects of their variance, whether conceptualised as a dynamic affective variable or a more stable personality trait like neuroticism. SCCs also tend to be inversely related to other psychological variables such as self-esteem and quality of life, as well as factors such as physical health, social support, and compensation behaviours. Despite the large variety of potential moderating variables, most studies to date have focused on only one or two, and so further work is necessary in order to more thoroughly explicate the complex relationships between them and SCCs.

CHAPTER 4

RESEARCH FORMULATION

Overview

The current chapter has two overarching aims: first, the background literature reviewed in previous chapters will be summarised, and will inform specific research questions and hypotheses. Second, detailed methodological details for the current studies are presented in their entirety (for the purposes of clarity), although the 'thesis by publication' format of this dissertation means that some details are repeated in the relevant manuscript chapters (i.e., Chapters 5, 6, and 7). Overlap is limited to the Introduction and Method sections of these chapters only, and is necessary for understanding the publication manuscripts in isolation.

Summary of Background Literature

The preface presented the development process and central aim of this research, which was to test an aetiological model of SCCs that implicated both cognitive (namely processing speed) and affective (namely anxiety) factors. Subsequent chapters reviewed the literature relating to SCCs and these possible aetiological factors, and consequently highlighted areas for further exploration. Specifically, Chapter 1 presented a systematic review and meta-analysis of evidence regarding the relationship between SCCs and objectively assessed memory performance. Findings from studies using objective memory assessment methods varied widely, but overall the effect size of the association between subjective and objective memory was small. Results suggested that affective factors likely play a key role in the aetiology of SCCs, with various cognitive factors, other psychological variables and different assessment methods also contributing. Notable was the substantial decrease in heterogeneity when analyses were limited to measures of memory only (as opposed to a range of cognitive functions). This evidence has informed the current research and its focus on memory measures specifically, as well as including study on the influence of assessment methods.

Chapter 2 reviewed age-related theories of cognitive change with a view to identifying how these mechanisms may underlie SCCs. Broadly, theories of cognitive ageing need to account for changes in many fluid abilities alongside relative stability of crystallised abilities.

Salthouse's (2000a) processing speed theory asserts that declines in processing speed (which occur earlier than that of other abilities) underlie age-related changes in all other cognitive abilities, and has supporting evidence. Alternative theories (e.g., Hasher & Zacks, 1988) propose that age-related declines in executive functioning abilities explain the patterns of performance on other tasks. Recent work however has highlighted that employing both types of theories as complementary accounts offers the most comprehensive explanation of objectively changes in cognitive function with age (e.g., Albinet et al., 2012; Baudoin et al., 2009; De Luca & Leventer, 2008). When it comes to explaining subjective changes (e.g., SCCs), evidence suggests that both processing speed and executive function (specifically inhibition) abilities are associated with SCCs (Benito-León et al., 2010; Mol et al., 2006; Rouch et al., 2008).

Chapter 3 reviewed the findings regarding the relationship between SCCs and a range of other (non-cognitive) factors. Of the psychological factors reviewed, depressive symptoms appear to show the strongest and most consistent association with SCCs, however anxiety and neuroticism also had relationships with SCCs, although they were less well studied. A number of demographic variables also demonstrate relationships with SCCs, although these were often inconsistent. Finally, Chapter 3 also reviewed the role of assessment methods in the measurement of SCCs, and highlighted that discrepant findings may be explained by variation in SCC measures.

Note on Terminology

Until this point, chapters have discussed the topic of subjective *cognitive* complaints, referring to reports of everyday difficulties that reflect any aspect of cognitive functioning (including, but not limited to, memory abilities). Chapter 2 used both search terms (subjective *cognitive* complaints and subjective *memory* complaints) in the interests of comprehensiveness and recent recommendations from Rabin et al. (2015). Literature discussed in Chapters 2 and 3 also encompassed both terms in order to remain consistent with the initial review. However, for the purposes of the upcoming experimental chapters, the focus narrows to subjective *memory* complaints (SMCs) specifically. Reasons for this shift are twofold. Firstly, the potential confounding of findings by variation in assessment methods (as discussed in Chapter 3) is likely to be reduced by restricting analyses to memory measures only. This logic is evidenced by the subgroup analysis in Chapter 1, which showed that restricting measures to memory complaints substantially reduced the heterogeneity of effect sizes. Secondly, studies which highlight the distressing nature of subjective complaints refer to memory specifically (e.g., Begum et al., 2012; Lachman, 2004; Paradise et al., 2011), meaning that currently the ecological validity of broader cognitive complaints is not yet fully established and therefore potentially not the focus of this work (which is to examine those cognitive complaints which cause distress in everyday functioning).

It is also noted that focusing analyses henceforth on memory complaints specifically will not necessarily restrict participants from reporting non-memory difficulties, because participants tend to conflate memory difficulties and those related to other cognitive abilities (Apolinario et al., 2015; Snitz et al., 2015).

Current Research

Collectively, the literature does support the model initially proposed in the Preface, whereby SMCs are thought to result from a combination of normal age-related declines in processing speed, and anxiety. However, other aetiologically relevant factors were also identified in Chapters 1-3 and are thus investigated further in Chapter 7. Justification for the tests used to measure these factors is presented on page 97. Due to the potential influence of assessment methods on SMCs, Chapters 5 and 6 explore this factor before testing the proposed aetiological model in Chapter 7.

Aims

The ultimate aim of the current research is to test an aetiological model of SMCs. Following review of the background literature, this objective has been broadened to include cognitive and psychological factors other than those initially present in the proposed model (i.e., processing speed and anxiety), and additional objectives have also been identified: first, to determine how SMCs differ as a function of the methods used to assess them, and second, to assess the degree to which different methods of assessing SMCs underlie the variability in their relationship with objective memory performance.

Constructs Included

Given that such a large number of constructs were identified during the literature review as being potentially related to SMCs, and that the aim was to test a comprehensive explanatory model of SMCs, as many variables were measured in the research as possible, while also being mindful of practical constraints such as time, cost, and importance. Consequently, the most important variables were deemed to be those that showed most promise in explaining SMCs, or that needed to be controlled for in order to assess other relationships. Important variables were processing speed, executive function (including inhibition), depressive symptoms, anxiety, neuroticism, objective memory performance, and SMC ssessment method. Other variables that needed to be controlled for and could be quickly assessed were gender, age, ethnicity, education level, occupational demands, general psychological wellbeing, perceived stress, social support, physical health, relevant neurological history, premorbid functioning, and motor speed.

Constructs that were identified during the literature review as potentially related to SCCs but are not directly examined in this research are (principally) compensatory strategies, effort, quality of life, self-concept, and personality traits of extraversion and openness. These variables were omitted due to practical constraints –they were less strongly related to SCCs than the primary constructs of interest, and would require the addition of a new scale to the testing procedures (e.g., the Memory Compensation Questionnaire; Dixon et al., 2001) which would extend the testing time beyond a reasonable length.

Research Questions and Hypotheses

1. To what extent do reported SMCs reflect the method with which they are assessed? This question is examined in Chapter 5. Based on a suggestion from Apolinario et al. (2012), it is hypothesised that a ‘cueing effect’ will be evident on questionnaire-prompted SMCs but not spontaneously reported SMCs.
2. How do assessment method-based differences in SMCs explain their relationship with objective memory performance? This question is examined in Chapter 6. It is hypothesised that SMCs gathered in response to a questionnaire will be less strongly related to objective memory performance than those gathered via open-ended questions, given previous results to this effect from Mattos et al. (2003).
3. To what extent do SMCs reflect cognitive, psychological and demographic factors? This question is examined in Chapter 7 and tests three hypotheses. First, the literature shows that the strongest and most reliable correlate of SMCs is depressive symptoms, and so it is hypothesised that this effect will be evident in the current research also. Secondly, anxiety is also expected to be related to SMCs following suggestions from the literature to this effect. It is also a known companion to depressive symptoms, and may influence the relationships between SMCs and cognitive abilities (Mol, van Boxtel, Willems, & Jolles 2006). Thirdly, the relationship between affective symptoms (anxiety and depression) and SMCs is expected to be moderated by processing speed and/or executive functioning abilities (rather than memory). This hypothesis is based on previous findings that deficits in aspects of higher cognitive functioning such as processing speed and executive functioning may manifest as the kinds of difficulties reported as SMCs (Potter & Hartman, 2006; Salthouse, 2000), and that affective disorders have cognitive effects. It is hypothesised that a stronger relationship between cognition

and SMCs will be found for individuals with more depressive symptoms than those with minimal depressive symptoms.

General Method

Ethical approval was obtained from the Massey University Human Ethics Committee (see Appendix B).

Participants

Figure 6 details the number of participants at each stage of the research and the process used to determine valid data.

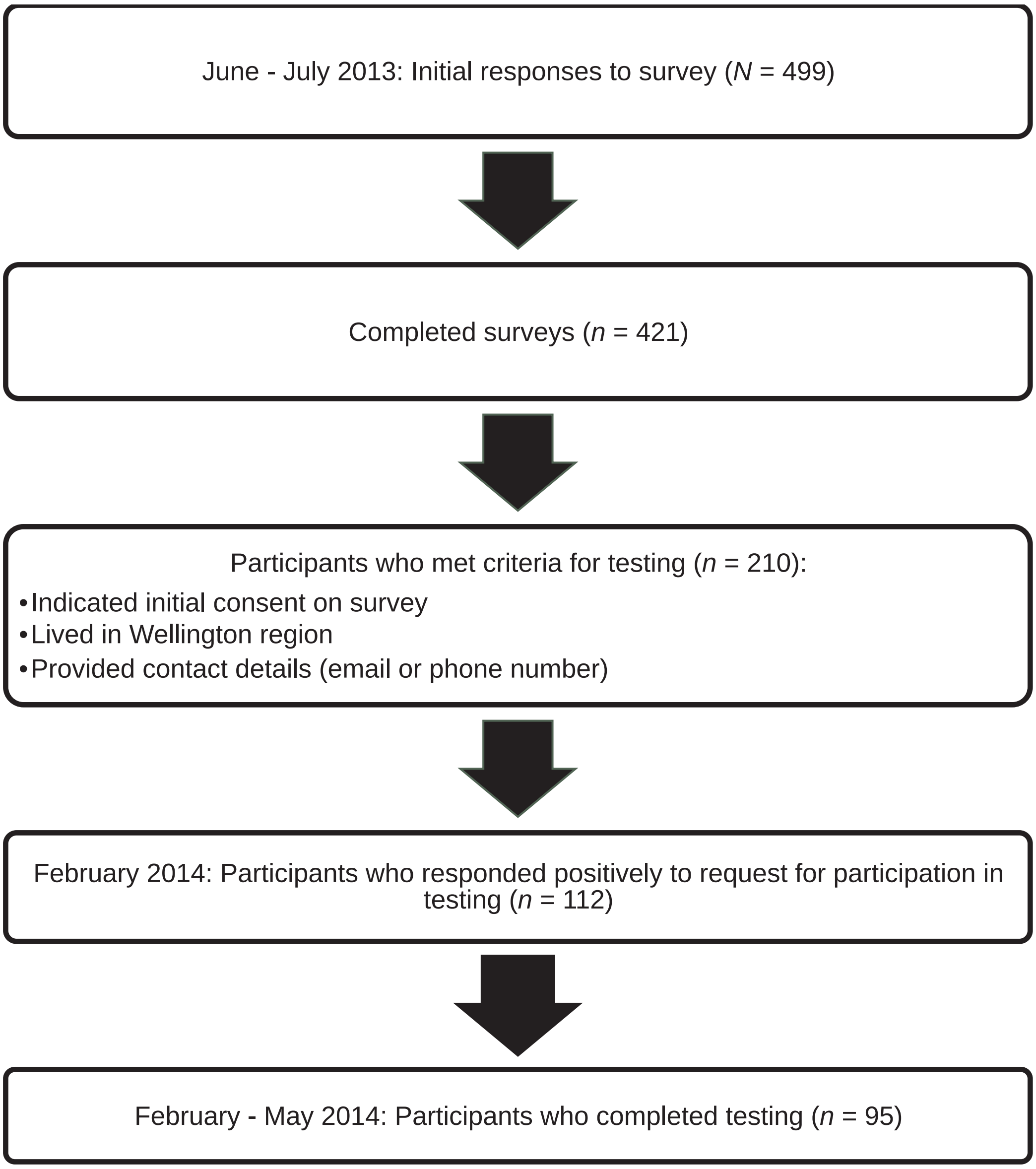

Figure 6. Number of potential participants at each stage of the research.

Participant recruitment comprised two stages: in the first stage, participants were recruited to complete a survey about everyday memory difficulties. First-stage recruitment was conducted via snowball sampling through the author's social networks, as well as advertising (see Appendix C) with local community groups such as senior citizens' clubs. After excluding data from participants who were less than 40 years old or who did not fill out at least two of the three sections of the survey, there was valid data from 421 participants.

Participants in the second stage were a subset of those participants who had completed the survey. Criteria for recruitment in the second stage were that participants: lived in the greater Wellington region (in order that they could be seen in person for memory testing); had indicated consent in the survey to being contacted about this second stage of the research; and had provided contact details (email address and/or phone number) in the survey by which they could be reached.

Two hundred and ten participants met these criteria and were contacted about potential participation in the second stage, which consisted of a single session (approximately 60 minutes in length) of neuropsychological testing. Initial recruitment actions for this stage were to send an email in October 2013 (approximately four months after participants had completed the survey) that informed participants about the progress of the research and that memory testing would begin in 2014 (see Appendix D). This was followed by another email in February 2014 that asked participants to indicate their interest in participation in the second stage of the research via either reply email or a phone-call to the author (see Appendix E).

G*Power analysis of sample size required for linear multiple regression analyses (R^2 change) showed that a minimum sample size of 87 was required in order for 80% statistical power to detect a medium-sized effect (f^2 = .15). Hence initial rationale was to collect data for at least this many participants, with a maximum of 100 - the maximum number estimated by the researcher that they were able to see within the timeframe for the research. One hundred and twelve participants responded to the email in February 2014 and were contacted by the researcher to arrange testing sessions.

Of these participants, 17 could not complete the testing sessions: 16 due to change in personal circumstances, and one due to the researcher not subsequently being able to successfully reach them on the contact details provided. A maximum of three attempts were made to contact each potential participant. Ninety-five participants successfully completed the testing sessions. In some cases participants failed to successfully complete, or declined to complete, a particular task within the testing session, which is reflected in the number of data points for each test. No participants were excluded from participation, as the focus of the research was to assess memory complaints across a wide sample. One participant chose for the testing to be conducted in a cafe, which invalidated their test results and so these were excluded from all group analyses, leaving a final sample size of $N = 94$.

Materials

Survey. ***Demographic and general information***. Participants completed a 51-item questionnaire containing three sections (see Appendix F). The first section concerned demographic characteristics; participants were asked to indicate their age, gender, education level, hours spent working or studying per week, whether they had ever sought professional help for their memory difficulties, and any neurological history. They were also asked to rate their mood and stress levels over the last six months, and their levels of social support, physical health, and physical exercise in relation to others their age on a 4-point scale (where 1 = Excellent, 2 = Good, 3 = Fair, 4 = Poor/bad).

Spontaneously reported memory difficulties. The second section assessed spontaneously reported memory difficulties. Participants were asked to describe the memory difficulties they experienced in daily life, and then to indicate how distressing these were by rating “how much of a problem” each difficulty was for them on a 7-point Likert scale (where 1 = not at all a problem, 4 = sometimes a problem, 7 = one of my biggest problems). Given that Apolinario et al. (2012) found participants spontaneously reported a maximum of six SMCs, participants here were able to list and rate up to seven different difficulties. Seven was chosen as the number most likely to allow adequate opportunity to report difficulties while minimizing encouragement of spurious responses. The ratings for “how much of a problem” each SMC was, were included based on the recommendation in Chapter 2 (Burmester et al., 2016) that both the presence and functional impact of SMCs be assessed.

Memory difficulties questionnaire. The third section comprised questionnaire assessment of memory difficulties. Participants were provided examples of potential memory difficulties and asked to again indicate their associated distress by rating “how much of a problem” each of these were for them in everyday life on a 7-point scale as above. Items were based on those from the following previous scales used to assess SMCs (see Appendix G):

- Everyday Memory Measure (Sunderland, Harris, & Baddeley, 1983) – 35 items
- Cognitive Failures Questionnaire (Broadbent, Cooper, Fitzgerald, & Parkes, 1982) – 25 items.
- Prospective and Retrospective Memory Questionnaire (Smith, Del Sala, Logie, & Maylor, 2000) – 16 items.
- Memory Complaint Questionnaire (Crook, Feher, & Larrabee, 1992) – six items.
- Metamemory Questionnaire – Ability Subscale (MMQ-A; Troyer & Rich, 2002) – 20 items.
- Memory Functioning Questionnaire – General Frequency of Forgetting subscale (Gilewski, Zelinski, & Schaie, 1990) – 28 items.
- Subjective Memory Complaints Questionnaire (SMCQ; Youn et al., 2009) – 14 items.
- Subjective Memory Questionnaire (Squire, Wetzel, & Slater, 1979) – 18 items.
- Classification instrument for spontaneously reported cognitive complaints developed by Apolinario et al. (2012) – 47 items.

These questionnaires were chosen because they were freely available, and either: used in other published studies as well (i.e., not an idiosyncratic set of questions particular to a single study); or were developed on the basis of existing questionnaires or qualitative reports from research participants (i.e. not just anecdotal evidence from the researchers). Items from these existing questionnaires were compiled and categorised into conceptually similar categories, using Krippendorf's (2013) content analysis procedures. From each category, a single example was used in the current questionnaire. For example, "How often do you misplace something you use daily, like your keys or glasses?" and "How often do you misplace something that you put away a few days ago?" from the MMQ-A (Troyer & Rich, 2002), and "Do you have difficulty in remembering where you placed objects?" from the SMCQ (Youn et al., 2009) were collapsed together to form the item "Trouble remembering where you have put things (e.g., keys, glasses)." Categories that referred to cognitive complaints other than memory (e.g., "Do you fail to see what you want in a supermarket, even though its there?", "Do you lose your temper and regret it?") or non-specific categories (e.g., "Do you think that you have a memory problem?") were excluded from the current questionnaire. This process resulted in 24 items compiled from an original total of 145 examples from nine freely available questionnaires. Appendix H contains full details of this process.

Neuropsychological testing. Participants in the second stage of the research completed a battery of standardised neuropsychological tests chosen to assess both the cognitive domains identified as important potential predictors of SMCs (i.e., processing speed and executive functioning) as well as covariates (memory, motor speed, depression, anxiety, and premorbid functioning). Covariates were selected based on the following criteria:

- being an established measure of one of the constructs of interest in the research (or a potential confound);

- availability of established norms for the ages of the participants (New Zealand norms were used where available);
- financial cost (freely available versions of tests were used where possible, as long as the psychometric properties of these versions were not significantly poorer than paid alternatives);
- estimated time taken to complete each test. In the interests of collecting data on as many variables as possible while restricting sessions to approximately 60 minutes in duration, shorter versions of tests were chosen where appropriate. Sixty minutes was set as the limit for session duration as it was judged to be the maximum possible time that participants could reasonably be expected to commit to the research in fair exchange for the $20 voucher they received as compensation, without discouraging participation from any individuals due to the time commitment required.

Some constructs were assessed with multiple measures. Processing speed was assessed with two measures as recommended by Groth-Marnat (2009), and because doing so did not add considerable administration time to the procedure but did increase reliability of the assessment. Executive function was assessed with multiple measures, reflecting the multi-faceted nature of this construct. Consistent with previous studies, these measures comprised the Stroop (Golden, 1978), targeting inhibition (as in Kemper & McDowd, 2008), and verbal fluency, targeting initiation and divided attention. Objective memory performance was also assessed with measures of immediate and verbal recall of both visual and verbal memory.

The following tests were administered, in the following order. Order of administration was fixed so that testing procedures were standardised.

Rey Auditory Verbal Learning Test: Immediate Recall (RAVLT; Strauss, Sherman, & Spreen, 2006). The experimenter reads aloud a list of 15 words, approximately one second apart, and the participant then repeats back as many words as they can remember. Their raw score is the number of words successfully recalled on each of five identical trials. These five trials (RAVLT 1-5) are followed by provision of a second list of words (RAVLT B) which the participant again recalls immediately. The next trial (RAVLT 6) requires the participant to now recall as many words as possible from the first list again (without the experimenter reading it aloud again). After an approximately 20 minute long filled delay, the experimenter asks the participant to again recall words from List A. This test targets verbal auditory memory and learning, as well as the effect of interference on memory, and immediate vs. delayed recall. Raw scores are the number of words correctly recalled on each trial (maximum score = 15 per trial).

Rey Complex Figure Test: Copy (RCFT; Meyers & Meyers, 1995). The experimenter provides the participant with a sheet of blank A4 paper (portrait orientation) and a pencil. The participant is then presented with an A4 card on which a design is printed, and asked to copy (not trace) the design as carefully as they can. The experimenter times how long the participant spends on the task before they complete their attempt. Two raw scores are obtained: the first is the time (in seconds) taken to complete the copy trial; the second is obtained using the standardised quantitative scoring method (Meyers & Meyers, 1995) whereby the design is divided into 18 components and each component is scored up to two points based on accuracy of appearance and location in relation to other components (maximum score = 36).

Stroop (Golden, 1978). The experimenter provides an A4 on which five columns of twenty words ("RED", "GREEN" and "BLUE") are printed in random order. The participant reads the words aloud (moving down each column) as quickly as they can until a timer (set for 45 seconds) indicates that they should stop. If the participant reaches the end of the card before the timer goes off, they are instructed to repeat the page again from the beginning. This procedure is repeated using two other A4 cards, the second with five columns of twenty rows of "XXXX" printed in either red, green, or blue ink and which the participant names the colours of each stimulus as they move down the columns. The third card contains the words "RED", "GREEN", and "BLUE" printed in either red, green, or blue ink (with the ink colour always incongruent with the word's meaning), and the participant is required to name the colour of the ink that each word is printed in. Raw scores are the number of words read/colours named correctly on each trial.

Rey Complex Figure Test: Immediate Recall (Meyers & Meyers, 1995).

Approximately three minutes after the completion of the RCFT copy trial, the participant is provided with an A4 sheet of paper and a pencil and asked to draw the figure shown earlier as best they can remember. There is no time limit. The raw score is calculated according to a structured scoring systems as detailed in Meyers and Meyers (1995).

Symbol Search (Wechsler, 2008). The participant is provided with a booklet containing six pages of rows of symbols. Each row consists of seven symbols, the first two ("target symbols") of which are visibly separated from the rest. Participants are instructed to look at the target symbols, and place a line through any other symbols on that row which match the two target symbols (or a line through a box indicating that there are no matching symbols). They then repeat this procedure for as many subsequent rows as possible. Prior to the test proper, there are three demonstration (completed by the administrator) and three practice (completed by the participant) rows. The raw score is the number of rows completed correctly within two minutes (maximum score = 60).

Coding (Wechsler, 2008). Given that processing speed was a key construct to be assessed, a second measure was also included as recommended by Groth-Marnat (2009). The participant is provided with a page containing a series of boxes, each divided horizontally into two sections. In the top section of each box is a number from 1 to 9, and the bottom sections are blank. At the top of the page there is a key containing boxes with the numbers 1-9 in the top sections and a corresponding symbol in the bottom sections. The experimenter instructs the participant to use the key to write the symbols that correspond to the given numbers into the bottom section of each box. They must fill out the boxes in order without skipping any. Prior to the test proper, the experimenter completes three demonstration trials and the participant completes six practice trials. The participant fills out the boxes as quickly as possible for two minutes. The raw score is the number of boxes completed correctly in this time (maximum score = 135). This task is a more recent version of the digit symbol substitution test used in previous work examining SMCs (e.g., Wahl et al., 2010).

Rey Auditory Verbal Learning Test: Delayed Recall (Strauss et al., 2006).

Approximately 20 minutes after the completion of the RAVLT Trial 1, the experimenter asks the participant to again recall words from List A. Scoring procedures are the same as for earlier RAVLT trials.

Beck Depression Inventory (Beck, Steer, & Brown, 1996). The Beck Depression Inventory (2nd edition; BDI-II) is a written self-report questionnaire containing 21 groups of sentences, each group describing various degrees of a symptom of depression. For example, the group describing sadness contains the sentences “I do not feel sad”, “I feel sad much of the time”, “I am sad all of the time”, and “I am so sad or unhappy that I cannot stand it”. The participant is required to indicate which sentence in each group best describes the way they have been feeling over the past two weeks. Each sentence is coded with a numerical value 0-3. The raw score is the total value of the sentences indicated by the participant (maximum score = 63).

State-Trait Anxiety Inventory (Spielberger, 1983). The State-Trait Anxiety Inventory (STAI) is a self-report questionnaire containing twenty statements relating to anxiety symptoms. For each, the participant indicates on a 1-4 scale the degree to which the statements accurately describe how they feel right now (state anxiety, where 1 = not at all, 2 = somewhat, 3 = moderately so, and 4 = very much so) and in general (trait anxiety, where 1 = almost never, 2 = sometimes, 3 = often, and 4 = almost always). Raw scores are the total values of their ratings for state and trait anxiety (maximum score for each = 80).

Rey Complex Figure Test: Delayed Recall (Meyers & Meyers, 1995). Approximately thirty minutes after the RCFT Copy Trial, the participant is again provided with an A4 sheet of paper and a pencil and asked to draw the figure shown earlier as best they can remember. There is no time limit. Scoring procedures are the same as for the RCFT Immediate Recall Trial.

Trail Making Test (Reitan, 1955). The Trail Making Test (TMT) contains two trials: for Trial A, the participant is provided with an A3 sheet of paper containing circled numbers 1-25 in apparently random placement across the page. They are instructed to draw a single line beginning at number 1 and touching all subsequent numbers in order, as quickly as they can. For Trial B, the participant is provided with a similar sheet of paper containing the numbers 1-13 and letters A-L in random arrangement. This time the participant is instructed to draw a line beginning at 1 and touching numbers and letters in order while alternating between the sets. In both cases a brief practice trial is completed prior to the tasks. As per the original instructions (Reitan, 1955), errors are pointed out by the administrator as they occur, and subsequently corrected by the participant. Raw scores are the time (in seconds) taken to complete each trial correctly.

Coin Rotation Task (original task by Mendoza, Apostolos, Humphreys, Hanna-Pladdy, & O'Bryant, 2009; New Zealand version as in Thornton, 2014).

The participant is given a NZ 20c coin and rotates it between their thumb and first two fingers as many times as possible in 20 seconds. Raw scores are the number of 180° rotations when using the dominant and non-dominant hands.

Verbal Fluency Test (Delis, Kaplan, & Kramer, 2001). Participants say aloud as many items as possible of a given category in one minute. This task contains six trials, with respective categories of: words beginning with F; A; S; animals; boys' names; and fruit and furniture (alternating between these categories). Raw scores are the number of unique words in the given category(/ies) generated for each trial.

National Adult Reading Test (NART; Nelson & Willison, 1991). The participant reads aloud a list of 50 words, chosen so that the pronunciation is not immediately obvious from their written form (e.g., "idyll", "sidereal", "nausea"). The raw score is the number of words pronounced correctly.

Procedure

As shown in Figure 6, the survey stage of the research was conducted from June to July 2013 and neuropsychological testing occurred between February and May 2014. Although this represents a time delay of up to eleven months between the two types of data collection, this research is referred to as cross-sectional in nature because such a delay represents only a minor change in the field of age-related changes in memory functioning. Salthouse (2010) states that cross-sectional age-related declines in cognitive variables are .01-.04 standard deviations per year, which requires a sample size of 5000 in order to be detected. He also recommends the use of cross-sectional studies for exploring new ideas (such as the model proposed here), with longitudinal studies to be employed later, once theories are refined. Other 'cross-sectional' studies have also incorporated similar intervals between different types of data collection (e.g., Ponds, van Boxtel, & Jolles, 2000).

Survey. The majority of participants (n = 379) completed the survey by following a link on the Massey University psychology research webpage, where they were first presented with the information sheet outlining the research (see Appendix I). After indicating consent, the survey took 5-10 minutes to complete. In order to include potential participants who did not have Internet access, hard copies of the survey were also distributed at meetings of various community groups such as senior citizens' clubs (*n* = 42).

Neuropsychological testing. Testing sessions were conducted by either the author (*n* = 77) or a research assistant (*n* = 18). The research assistant was trained in the administration, scoring and interpretation of the tests used. Due to the snowball sampling method by which some participants had been recruited, a small number of them were known to the author. In order to prevent this relationship from affecting participants' performance on the tests, these participants were seen by the research assistant (who was unknown to them) instead.

Eighty-five participants completed the testing session at the Massey University Psychology Clinic in Wellington. Ten participants were unable to visit the clinic during business hours due to work or other commitments. In these cases the researcher visited participants at a location of their choice (their home or work) instead. It was explained to participants that the testing environment needed to be a quiet place with as few distractions as possible.

Sessions were conducted in a quiet room free from distractions. At the beginning of each session, participants were offered tea, coffee or water. The experimenter explained the general procedure of the testing session to them as well as having them read a copy of the information sheet (which was also provided to them via email when each testing session booking was confirmed; see Appendix J) and sign the consent form (see Appendix K). The experimenter explained there would be a range of different tasks, and that while some would be more difficult than others, participants should just attempt to do their best. Some tasks were an obvious assessment of memory, whereas others might seem less clear and that in some of these cases the task was targeting other abilities that might be related to memory instead (such as attention). Participants were encouraged to ask questions throughout the session if anything was unclear, and to let the experimenter know if they decided that they would prefer not to complete any particular task.

Approximately halfway through the testing session, while participants were completing the BDI-II and the STAI, the administrator briefly left the room in order to provide participants with some privacy while filling out the questionnaires (as their emotional nature may have made it uncomfortable for some participants to answer them honestly in the presence of the researcher, who they were meeting for the first time). During this time, the administrator prepared tea, coffee and biscuits for the participant and upon returning, asked if there were any elements of the questionnaires that the participants wanted to discuss further, and did so if necessary.

At the completion of the session, participants were provided with a psychoeducational pamphlet containing information about the relationship between memory and ageing (see Appendix L). They were asked if they would like to receive a written summary of the overall findings of the research project, and provided with a voucher for either petrol or groceries (their choice), to the value of $20. Four participants declined the voucher. Participants were also asked whether they would like to be contacted and given feedback about the results of their testing. It was emphasised that while any concerns (if present) would be brought to their attention, this feedback would primarily be focused on communicating the strengths that they showed during testing. In cases where concerns were raised by their results (such as a score on the BDI-II that indicated levels of depressive symptoms in the mild, moderate or severe ranges, or especially low cognitive scores that were not explainable by any history the participants disclosed), this was discussed with the author's supervisor and then with the participant. Conversations with the participant often led to discussion of explanatory factors that had not been mentioned in the session (such as relevant life stressors), and also provision of help services (such as free-phone lines) that may have been useful to the participant. Participants were also advised that if they had any concerns they could visit their general practitioner, or attend the Psychology Clinic privately if they wished to continue seeing either the researcher, their supervisor, or another clinician. All participants indicated that they wanted feedback on their results. First attempts to contact participants with their feedback were always made within the week following their testing session. An example of participants' results and feedback is given in Appendix M.

Test Scoring and Norms

Survey

Qualitative data. Qualitative responses to the second section of the survey were analysed with content analysis (Krippendorf, 2013). This approach was selected because each response (memory difficulty) was relatively brief, and an aim was to identify the frequency with which various themes occurred in the data. Content analysis is suited to the quantification of qualitative data via methods such as frequency counts, even for very small units of analysis (e.g., words or phrases), and provides an overview of themes in the data which can be validated by different individuals (Krippendorf, 2013; Wilkinson, 2000). Memory difficulties reported by participants were analysed both inductively and deductively. Given that the researcher had some knowledge of existing categories of memory difficulties due to the use of previous SMC questionnaires in constructing the survey, interpretation of the themes in this data was deductive in that it reflected knowledge of existing categories to some extent. However, the data was analysed by identifying and coding themes and content that repeated in the data, thus reflecting an inductive process also. Reports of memory difficulties were separated into semantic units for each type of memory difficulty referred to, so that each unit could be represented by a single code (Krippendorf, 2013). The number of units bearing each coding category was computed, with the most commonly occurring categories being considered most important. All qualitative data was also coded by a second rater, and this inter-rater reliability data is reported on page 126.

Quantitative data. Quantitative analyses of the data comprised frequency counts and comparisons of means. Frequency counts resulted from content analysis of qualitative data as outlined above, and indicated the prevalence of SMCs according to the coding criteria developed. Paired samples t-tests were used to compare the mean distress ratings given to SMCs elicited under the two assessment methods, because assessment method was a within-subjects variable. Given the conventional parameters of α = .05 and β = 0.8, a G*Power analysis showed that the sample size of at least 351 would be necessary in order to detect a small effect (*d* = 0.2). Significance values were adjusted for multiple comparisons using the Bonferroni correction. Quantitative data analyses were completed using the SPSS software package (v20) and an online R-based calculator (Preacher, Curran, & Bauer, 2006).

Neuropsychological Testing

Each participant's scores were calculated by the same administrator who had conducted the testing session with them. Raw scores were calculated according to the procedure outlined by the respective test authors, and then standardised according to the best norms available for each test. Norms used are detailed later, in Table 7. Norms were selected based on the optimal combination of the following factors:

- being freely available
- reflecting the largest sample size
- having population characteristics that matched the research sample (e.g., New Zealand norms were used where available)
- being specific to the age group sampled (i.e., in all cases the norms chosen matched the age of the sample).

In some cases the norms chosen provided means and standard deviations for the norm sample, which were used to calculate standardised scores for each participant on those tests according to the standard formula for calculating *z*-scores (i.e., $z = \frac{x-\mu}{\sigma}$). In other cases norms provided standardisation tables by which a raw score was assigned to a standardised score (e.g., Verbal Fluency) or a *T*-score (e.g., Stroop). In these cases the standardised score was first calculated and then converted to a *z*-score applying the same formula as above. The NART was designed as an estimation of IQ level, and so for this test the number of errors made was subjected to a formula specific to New Zealand participants that estimated their IQ based on their score on the test, gender, ethnicity, and education level (Barker-Collo, Thomas, Riddick, & de Jager, 2011). This estimated IQ was then converted to a Z-score using the traditional IQ mean and standard deviation of 100 and 10 respectively.

In order to analyse individual patterns of results and feed these back to participants, all *z*-scores were plotted on a normal distribution bell-curve and then interpreted by either the author or a research assistant. In cases where interpretations were unclear or ambiguous, the primary supervisor was consulted. A cultural advisor to the research was also consulted for interpreting results for participants of Māori descent.

Preliminary Analyses

Survey

Memory difficulties reported by participants were coded into 23 categories, of which 22 described specific content. Code descriptions, examples of each code, and descriptive statistics for the self-reported SMCs are shown in detail later, in Table 4 (page 123). In some instances two or more codes can appear to reflect similar difficulties (e.g., “What I was doing” and “What I came in here for” both involve the loss of an intention during its execution), but participants often discussed them in specific terms and they were therefore coded separately. Following initial category formation and coding, a second rater independently coded the qualitative data (N = 1306) according to the definitions provided in Table 4. Agreement was defined as concordance of both raters on the category each semantic unit was assigned to. Initial inter-rater agreement was 93.19%, with Cohen’s $\kappa = 0.93$. Discussion of units where raters disagreed on the coding category resulted in changes to the ratings for all remaining units (n = 89), with final inter-rater agreement being 100%.

In order to represent findings only for those SMCs that caused some subjective level of distress, survey results in Chapters 5 and 7 exclude any SMC distress ratings of 1 (= “not at all a problem”). However in the interests of completeness, parallel versions of these analyses (including distress ratings of 1) are presented in Appendix N.

Neuropsychological Testing

Missing data. Valid data was collected for all measures, except for missing data for one participant on the RCFT and two participants on the CRT due to changes in the testing procedure - these participants were the first to complete the testing sessions and changes in the tests used resulted from administrator observations about these sessions. There was also missing data for one participant who did not complete the STAI, and two participants who did not complete the BDI-II.

Inter-rater reliability. Due to the complicated characteristics of some norms used, and the subjective element of interpretation for some tests (e.g., RCFT), there was potential for results to vary due to clerical errors and interpretative differences. Consequently, each participant’s test scores were also scored by one of two other raters and the results compared.

Initial inter-rater agreement was 74.14%, with a one-way random intra-class correlation indicating excellent inter-rater agreement, *ICC* = .952. Disagreements were discussed among the researcher, research assistant, and two raters. All of them were found to be due to clerical errors (e.g., applying incorrect norms to the participant’s score on a particular test). Correction of these errors resulted in final inter-rater reliability of 100%.

In all cases *z*-scores were used in further statistical analysis.

Administrative effects. Multivariate analyses of variance were conducted in order to assess the impact of administrative differences on the participants’ test scores, where dependent variables were the 31 test scores for each participant and predictor variables were testing location (at the Massey University Psychology Clinic or elsewhere), test administrator (the primary researcher or the research assistant) and secondary test scorer (one of two scoring assistants). There were no main effects of testing location (p = .849), administrator (p = .587) or scorer (p = .628).

CHAPTER 5

ASSESSING SUBJECTIVE MEMORY COMPLAINTS: A COMPARISON OF SPONTANEOUS REPORTS AND STRUCTURED QUESTIONNAIRE METHODS

This chapter has been published in *International Psychogeriatrics:*

Burmester, B., Leathem, J., & Merrick, P. (2015). Assessing subjective memory complaints: A comparison of spontaneous reports and structured questionnaire methods. *International Psychogeriatrics, 27*(1), 61–77. doi:10.1017/S1041610214001161

A poster based on this chapter is provided in Appendix O:

Burmester, B., Leathem, J., & Merrick, P. (2014, April 13). *Assessing subjective memory complaints.* Poster session presented at the New Zealand College of Clinical Psychologists Conference, Christchurch, New Zealand.

Abstract

Subjective memory complaints (SMCs) are a common occurrence for adults, which increase with age, and cause considerable distress. Traditionally SMCs have been assessed by either questionnaires, which ask whether a person has experienced given examples of SMCs, or open-ended questions which elicit spontaneous reports of SMCs. However, little is known about how these methods of assessment might influence reporting of SMCs. Four hundred and twenty-one adults aged 40 and above were surveyed about SMCs using spontaneous report and questionnaire methods. As expected, spontaneously reported SMCs were fewer in number and rated more distressing overall than SMCs endorsed on a questionnaire. However, comparison of individual SMCs revealed that distress ratings tended to be higher when assessed in a questionnaire than spontaneously reported, which may be due to the context of a questionnaire causing inflated ratings. Participants also reported SMCs which were not well assessed by the questionnaire, including some which were among the most distressing SMCs overall. Conversely, other SMCs were over-sampled by the questionnaire and did not feature in spontaneous reports. Implications for clinical assessment of SMCs are that open-ended questioning might be preferable to initial use of prescriptive questionnaires, in order to elicit SMCs that are most distressing. While use of questionnaires may reveal endorsement of a wider range of SMCs than are spontaneously reported, they can take focus away from, or even fail to assess, those SMCs which cause most subjective distress (and therefore should be the target of interventions).

Introduction

Everyday lapses or memory difficulties are commonly reported by older adults (Jonker, Launer, Hooijer, & Lindeboom, 1996), tend to increase with age (Ginó et al., 2010), and can be a source of considerable concern about the potential decline of cognitive abilities with age. Memory complaints are associated with lower quality of life (Mol et al., 2007; Montejo, Montenegro, Fernández, & Maestú, 2012), and in some cases are more distressing than physical conditions such as heart attacks (Begum, Morgan, Chiu, Tylee, & Stewart, 2012).

However, the relationship between subjectively reported memory complaints and actual memory performance is complex. Some studies have found a positive relationship between subjective memory complaints (SMCs) and objective memory performance (Bassett & Folstein, 1993; Jonker et al., 1996), and suggest that SMCs could be an important indicator of potential cognitive decline (as in conditions such as mild cognitive impairment). Other studies have found no evidence of this association (Jungwirth et al., 2004), or that factors such as mood and physical health confound the relationship between subjective and objective memory (Jonker, Geerlings, & Schmand, 2000; Reid & MacLullich, 2006).

Differences among these findings have been in part attributed to the methods used to assess SMCs (Abdulrab & Heun, 2008; Apolinario et al., 2013). Some studies determine the presence or absence of SMCs by one simple yes/no question (e.g., "Do you find that you have trouble with your memory?"; Bassett & Folstein, 1993); others use similar questions with two or more response options (e.g., “Do you have complaints about your memory?” - “no”; “sometimes, but is a problem”; “yes, is a problem”; or “yes, is a serious problem”; Geerlings, Jonker, Bouter, Adèr, & Schmand, 1999); still others may use a set of questions or an established questionnaire measure of SMCs (Jorm, Christensen, Korten, Jacomb, & Henderson, 2001; Smith, Petersen, Ivnik, Malec, & Tangalos, 1996). Questionnaires tend to provide a number of examples of memory difficulties, and ask participants to rate how often they experience each of them. While questionnaires undoubtedly garner more detailed information than single-question assessment of SMCs, Mattos et al. (2003) found that SMCs assessed via questionnaire methods were not associated with objective memory impairment, whereas assessment of SMCs with an open-ended question was predictive of actual impairment and thus demonstrated greater clinical utility. Questionnaires also only assess the presence of those particular difficulties that comprise their items. The items used vary widely across different questionnaires, and how well they represent the actual memory difficulties experienced by adults is undocumented.

As well as a relative lack of research concerning methods of assessing SMCs *without* providing fixed examples of particular memory difficulties (such as open-ended questioning), current questionnaires are potentially missing the kinds of SMCs that are most distressing for adults. Presenting pre-existing examples of SMCs discourages the discussion of any other SMCs participants might have experienced, and indeed older adults tend not to volunteer such additional information or seek help for their memory complaints (Begum et al., 2012). Questionnaire methods also fail to assess which kinds of SMCs are the most distressing, instead focusing on the frequency of their occurrence.

One appropriate point at which to determine which complaints are the most subjectively distressing would be during the construction of SMC questionnaire measures. However, many of the questionnaires commonly used to assess SMCs appear to have neglected this opportunity, and instead the initial types of complaints that formed questionnaire items were constructed by the researchers without apparent consultation with participants. For example, Broadbent, Cooper, Fitzgerald, and Parkes' (1982) Cognitive Failures Questionnaire was assembled from the experiences of the authors or their acquaintances. Items in Crook, Feher, and Larrabee's (1992) Memory Complaint Questionnaire (MAC-Q) were selected "based on clinical experience and empirical evidence regarding patterns of age-related memory loss" (Crook et al., 1992, p. 167), with no supporting evidence given. Other questionnaires selected items based on those in previous measures (e.g., Metamemory Questionnaire; Troyer & Rich, 2002), or omitted information about the source of items altogether (e.g., Smith, Del Sala, Logie, & Maylor, 2000).

More recently, one attempt has been made at understanding memory complaints from a more inclusive perspective. Apolinario and colleagues (2013) assessed SMCs among older adults via both open-ended and questionnaire methods. The number of complaints reported spontaneously and the number of questionnaire items participants endorsed were moderately correlated, yet the kinds of information gathered via each method were only somewhat consistent. Many questionnaire items that participants endorsed were not mentioned spontaneously, demonstrating a cueing effect. One explanation for this discrepancy is that endorsed questionnaire items likely do reflect actual difficulties experienced by participants, but not necessarily those which are most distressing. These may instead be better represented by the spontaneously reported complaints, which reflect difficulties with the greatest functional impact and greatest salience for an individual. However, these results are limited in that the questionnaire used (the MAC-Q; Crook et al., 1992) contained only five examples of SMCs. Thus concerns about failing to assess a wide range of SMCs remain to be addressed, particularly when considering the large range of different complaints that may be reported by individuals – Apolinario et al. (2013) found 37 different categories of spontaneously reported complaints.

The current study has two aims: first, to understand what kinds of memory complaints adults report spontaneously (regardless of their potential cause); and second, to examine how different methods of information gathering might affect these reports. Understanding how two methods of assessment (prescriptive questionnaires vs. open-ended questioning) affect reporting of SMCs will consequently inform how best to accurately assess SMCs. Unlike many previous assessment instruments (which have assessed the presence or frequency of occurrence of each SMC), here the degree of distress related to each SMC is assessed, in order to assess subjective impact regardless of how often a particular SMC occurs or what may have caused it.

Consistent with the cueing effect documented by Apolinario et al. (2013), participants were expected to report fewer complaints spontaneously than they endorsed under questionnaire methods. The types of complaints and degrees of associated distress endorsed were expected to vary according to the assessment method.

Method

Participants

Because SMCs begin to increase during middle age (Ponds, van Boxtel, & Jolles, 2000), participants aged 40 and above were sampled. Participants were recruited via snowball sampling through the researcher's social networks and advertising through local community groups. After excluding cases that were less than 40 years old, the sample comprised 421 participants (72.00% female). The majority of participants were of Pākehā/New Zealand European (79.60%) descent, with the remainder Māori (5.70%), Pasifika (1.90%), Asian (1.20%), and other ethnicities (10.90%). Three people did not answer this question. Participants aged 40-49 comprised 30.20% of the sample, while 25.10% were aged 50-59, 18.70% aged 60-69, 17.20% aged 70-79, and 8.80% aged 80 or above. The majority of the sample (72.50%) was tertiary educated and 39.40% worked or studied for at least 40 hours per week. Table 3 displays the sample characteristics broken down by age group.

Measures

Participants completed a 51-item survey containing three sections. The first concerned demographic characteristics; participants were asked to indicate their age, gender, education level, hours spent working or studying per week, whether they had ever sought professional help for their memory difficulties, and any neurological history. They were also asked to rate their mood and stress levels over the last six months, and their levels of social support,

Table 3. Descriptive Statistics of Sample by Age Group

	Total sample	Age Group									
	40+	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
	(*n* = 420)	(*n* = 60)	(*n* = 67)	(*n* = 65)	(*n* = 41)	(*n* = 43)	(*n* = 35)	(*n* = 36)	(*n* = 36)	(*n* = 29)	(*n* = 8)
Education[a]	4.21 (1.63)	4.82 (1.46)	4.68 (1.17)	4.70 (1.50)	4.20 (1.42)	4.16 (1.63)	3.66 (1.91)	3.74 (1.52)	3.32 (1.74)	3.21 (1.79)	3.63 (1.92)
Employment[b]	3.52 (1.66)	4.22 (1.43)	4.38 (1.21)	4.48 (1.35)	4.41 (1.34)	3.74 (1.45)	2.69 (1.41)	1.83 (.85)	2.11 (1.12)	1.72 (.92)	1.43 (1.13)
Mood[c]	2.02 (.69)	2.00 (.70)	2.19 (.74)	2.20 (.71)	2.24 (.73)	1.83 (.73)	2.03 (.51)	1.94 (.42)	1.72 (.78)	1.86 (.52)	1.50 (.54)
Stress[c]	2.25 (.71)	2.53 (.68)	2.40 (.68)	2.42 (.73)	2.49 (.68)	2.14 (.86)	2.17 (.56)	2.00 (.59)	1.75 (.60)	1.93 (.53)	1.86 (.69)
Social support[c]	1.89 (.75)	1.98 (.83)	2.00 (.80)	2.09 (.77)	1.95 (.81)	1.79 (.74)	2.00 (.64)	1.60 (.50)	1.62 (.65)	1.66 (.61)	1.50 (.54)
Physical health[c]	1.85 (.67)	2.03 (.80)	1.95 (.67)	1.77 (.58)	1.85 (.76)	1.67 (.64)	1.89 (.67)	1.83 (.79)	1.86 (.54)	1.72 (.70)	1.63 (.52)
Exercise[c]	2.28 (.86)	2.50 (.85)	2.42 (.92)	2.52 (.90)	2.34 (.76)	2.00 (.86)	2.17 (.74)	2.17 (.81)	2.06 (.77)	2.00 (.85)	1.75 (.71)

Note. Statistics are presented as means (standard deviations in parentheses).
a. 1 = High school attendance, 2 = School certificate or NCEA Level 1, 3 = University entrance, Bursary, or NCEA Level 3, 4 = Tertiary certificate or diploma, 5 = Bachelor's degree, 6 = Postgraduate education.
b. Number of hours spent working or studying per week: 1 = Not applicable, 2 = less than 20 hours, 3 = 20-29 hours, 4 = 30-39 hours, 5 = 40-49 hours, 6 = 50-59 hours, 7 = 60 hours or more.
c. 1 = Excellent, 2 = Good, 3 = Fair, 4 = Poor/Bad.

physical health, and physical exercise in relation to others their age on a 4-point scale, (1 = Excellent, 2 = Good, 3 = Fair, 4 = Poor/bad). See Table 3 for these descriptive statistics by age group.

The second section assessed spontaneously reported SMCs. Participants were asked to describe the memory difficulties they experienced in daily life, and then to indicate how distressing these were by rating "how much of a problem" each difficulty was for them on a 7-point Likert scale (1 = not at all a problem, 4 = sometimes a problem, 7 = one of my biggest problems). Given that Apolinario et al. (2013) found participants spontaneously reported a maximum of six SMCs, participants here were able to list and rate up to seven different difficulties. Seven was chosen as the number most likely to allow adequate opportunity to report difficulties while minimizing encouragement of spurious responses.

The third section comprised questionnaire assessment of SMCs. Participants were provided examples of potential memory difficulties and asked to again indicate their associated distress by rating "how much of a problem" each of these were for them in everyday life on a 7-point scale as above. Items were based on those from the following previous scales used to assess SMCs:

- Everyday Memory Measure (Sunderland, Harris, & Baddeley, 1983) – 35 items
- Cognitive Failures Questionnaire (Broadbent et al., 1982) – 25 items.
- Prospective and Retrospective Memory Questionnaire (Smith et al., 2000) – 16 items.
- Memory Complaint Questionnaire (Crook et al., 1992) – six items.
- Metamemory Questionnaire – Ability Subscale (Troyer & Rich, 2002) – 20 items.
- Memory Functioning Questionnaire – General Frequency of Forgetting subscale (Gilewski, Zelinski, & Schaie, 1990) – 28 items.
- Subjective Memory Complaints Questionnaire (Youn et al., 2009) – 14 items.
- Subjective Memory Questionnaire (Squire, Wetzel, & Slater, 1979) – 18 items.
- Classification instrument for spontaneously reported cognitive complaints developed by Apolinario et al. (2013) – 47 items.

These measures were those found during a literature review to be both freely available and either: used in other studies as well (i.e., not an idiosyncratic set of questions particular to a single study); or were developed on the basis of existing questionnaires or qualitative reports from research participants (i.e., not just anecdotal evidence from researchers). Items from these existing questionnaires were compiled and categorised into conceptually similar categories, from which a single example was used in the current questionnaire. For example, "How often do you misplace something you use daily, like your keys or glasses?" and "How often do you misplace something that you put away a few days ago?” from the MMQ-A (Troyer & Rich, 2002), and “Do you have difficulty in remembering where you placed objects?” from the SMCQ (Youn et al., 2009) were collapsed together to form the item “Trouble remembering where you have put things (e.g., keys, glasses)”. Categories that referred to cognitive complaints other than memory (e.g., “Do you fail to see what you want in a supermarket even though it’s there?”, “Do you lose your temper and regret it ?”) or non-specific categories (e.g., “Do you think that you have a memory problem?”) were excluded from the current questionnaire. This process resulted in 24 items compiled from an original total of 145 examples from nine questionnaires.

Procedure

The majority of participants completed the survey by following a link on the Massey University psychology research webpage, where they were first presented with the information sheet outlining the research. Before proceeding to the survey proper participants needed to indicate their consent. The survey took 5-10 minutes to complete. In order to also include potential participants who did not have Internet access, hard copies of the survey were also distributed at meetings of various community groups (such as senior citizens’ clubs), which yielded data for 42 participants.

Data Analysis

Qualitative responses to the second section of the survey were analyzed via content analysis, as outlined by Krippendorff (2013). This approach was selected because each response (SMC) was relatively brief, and an aim was to identify the frequency of occurrence of various themes in the data. Content analysis is suited to the quantification of qualitative data via methods such as frequency counts, even for very small units of analysis (e.g., words or phrases), and provides an overview of themes in the data which can be validated by different individuals (Krippendorff, 2013; Wilkinson, 2000). Memory difficulties reported by participants were analyzed both inductively and deductively. Given that the researcher had some knowledge of existing categories of memory difficulties due to the use of previous SMC questionnaires in constructing the survey, interpretation of the themes in this data was deductive in that it reflected knowledge of existing categories to some extent. However, the data was analyzed by identifying and coding themes and content that repeated in the data, thus reflecting an inductive process also. Reports of memory difficulties were separated into semantic units for each type of memory difficulty referred to, so that each unit could be represented by a single code (Krippendorff, 2013). The number of units bearing each coding category was computed, with the most commonly occurring categories being considered most important. One other rater also coded all qualitative data, and inter-rater reliability data is also reported on page 126.

Quantitative analyses of the data comprised frequency counts and comparisons of means. Frequency counts resulted from content analysis of qualitative data as outlined above, and indicate the prevalence of SMCs according to the coding criteria developed. Paired samples t-tests were used to compare the mean distress ratings given to SMCs elicited under the two assessment methods, because assessment method was a within-subjects variable. Given the conventional parameters of $\alpha = .05$ and $\beta = 0.8$, a G*Power analysis showed that the sample size of at least 351 would be necessary in order to detect a small effect ($d = 0.2$). Significance values were adjusted for multiple comparisons using the Bonferroni correction. Quantitative data analyses were completed using the SPSS software package (v20).

Results

Preliminary Analyses

Due to the variability in demographic and other characteristics of the sample, independent samples t-tests were performed on the four main dependent variables (frequency of endorsement and mean distress ratings for SMCs as assessed by both open-ended and questionnaire methods) in order to check for any differences between participants who differed on the basis of age, ethnicity, and method of survey administration.

Analyses revealed that participants of Pākehā/New Zealand European descent did not differ significantly from participants of other ethnicities on either the number of SMCs reported spontaneously (p = .746) or on the questionnaire (p = .634), or the distress ratings assigned to SMCs reported spontaneously (p = .112) or on the questionnaire (p = .523). Similarly, there were no significant differences between participants who completed the survey online and those who completed hard copies, either on distress ratings assigned to spontaneous reports (p = .291) or questionnaire items (p = .401), or in the number of questionnaire items endorsed (p = .117). However, participants who completed the survey online (M = 2.85, SD = 1.45) did spontaneously report significantly more SMCs (t(46.207) = 2.97, p = .005) than those who completed hard copies of the survey (M = 2.31, SD = .93).

Middle-aged adults (ages 40-64; M = 3.73, SD = 1.09) assigned significantly higher distress ratings to their spontaneously reported SMCs (t(378) = 2.82, p = .005) than older adults (aged 65 and above) did (M = 3.40, SD = 1.01). The same pattern was evident on the questionnaire items (t(419) = 2.78, p = .006), with middle-aged adults (M = 3.22, SD = .80) rating the items they endorsed as more distressing than older adults did (M = 3.00, SD = .71). Middle-aged adults (M = 14.84, SD = 5.63) also endorsed a significantly greater number (t(419) = 3.49, p = .001) of questionnaire items than older adults (M = 12.82, SD = 5.67), however there was no significant difference in the number of SMCs reported spontaneously between the groups (p = .155).

Differences between the ten age groups (listed in Table 3) on psychosocial variables (mood, stress, social support, physical health, and exercise) were analysed using one-way analyses of variance. Levene's test was significant for mood and stress (p < .001 for both), so Welch's statistic is reported for these variables. There was a significant difference between age groups for mood (F(9,106.27) = 3.26, p = .002), stress (F(9,98.21) = 7.08, p < .001), social support (F(9.406) = 2.74, p = .004), and exercise (F(9,409) = 2.92, p = .002), but not for physical health (p = .241). Post-hoc Games-Howell procedures were used to analyse pairwise differences (due to the violation of homogeneity of variance assumptions in some cases and unequal group sizes in all cases), and showed no significant pairwise differences for mood or exercise. Participants aged 50-54 (M = 2.09, SD = .77) and 70-74 (M = 1.60, SD = .50) differed significantly on social support ratings (p = .007, d = .76), as did stress ratings for those aged 40-44 (M = 2.53, SD = .68) from ages 70-74 (M = 2.00, SD = .59, p = .004, d = .84), 75-79 (M = 1.75, SD = .60, p < .001, d = 1.22), and 80-84 (M = 1.93, SD = .53, p = .001, d = 0.99), those aged 45-49 (M = 2.40, SD = .68) from ages 75-79 (p < .001, d = 1.01) and 80-84 (p = .016, d = 0.77), those aged 50-54 (M = 2.42, SD = .73) from ages 75-79 (p < .001, d = 1.00) and 80-84 (p = .018, d = 0.77), and those aged 55-59 (M = 2.49, SD = .68) from ages 70-74 (p = .035, d = 0.78), 75-79 (p < .001, d = 1.16), and 80-84 (p = .009, d = 0.92).

Despite the presence of some significant differences on the basis of demographic and psychosocial variables, all participants were included in subsequent analyses in order to remain consistent with the aims of the study – i.e., to investigate what types of memory complaints individuals report (regardless of the potential cause) and how these differ according to assessment method.

Spontaneously Reported Memory Difficulties

Memory difficulties reported by participants were coded into 23 categories, of which 22 described specific content. Table 4 shows the code descriptions, examples of each code, and descriptive statistics for the spontaneously reported SMCs. In some instances two or more codes can appear to reflect similar difficulties (e.g., “What I was doing” and “What I came in here for” both involve the loss of an intention during its execution), but participants often discussed them in specific terms and they were therefore coded separately.

Table 4. Coding Categories and Descriptive Statistics of Spontaneously Reported Memory Difficulties

Code Title	Description	Examples	*n*	*M* (*SD*)
Multiple things at once	Having difficulty remembering multiple pieces of information at a time (e.g., phone numbers).	"Trying to make decisions based on the facts that I have gathered." "Can't retain for example the whole of an address or phone number without looking again." "Trying to remember a number of things simultaneously."	18	4.53 (1.37)
People	Not recognizing people or being able to remember their faces.	"Not recognizing faces of people I have met." "Bringing faces of old friends to mind." "I can remember people's voices but can't remember their faces."	10	4.50 (1.51)
Things others have told me	Not being able to remember whether or what someone else has told one.	"Forgetting instructions soon after being given them." "Forgetting things people have told me previously." "What my wife tells me."	47	4.50 (1.42)
Facts	Difficulty recalling semantic knowledge such as trivia, learned facts, known phone numbers or particular information.	"Forgetting online banking login, telephone numbers." "Spelling of words." "Knowing that I know the answers to questions but not being able to recall them."	74	4.35 (1.46)
Procedural	Remembering physical sequences of movement or actions.	"How to operate my computer when I know I've done the thing I want to do many times before." "Remembering the fingering of the notes on a flute." "Forgetting learned sports activities – martial arts sequence of movements."	14	4.23 (1.09)
Completed actions	Not being able to remember whether one has done an intended task or not.	"When shopping I forget if I already bought something the day before." "Remembering if I have done a certain thing like taking pills." "Can't remember if I locked the door/closed windows."	19	4.06 (1.39)
Where I have put things	Not being able to remember where they put a particular item.	"Forgetting where I have parked my car." "Not remembering where I left the car keys or purse." "Being unable to find my glasses."	64	3.98 (1.07)

Code Title	Description	Examples	*n*	*M* (*SD*)
Content of books, movies etc.	Not remembering having already seen a movie or reading something, or forgetting the content of books, movies, etc.	"Forgetting the details of what's happened in previous chapters when reading a book." "Forgetting content of reading material, movie details, storyline etc." "I completely forget if I have watched some films."	38	3.97 (1.31)
What I was doing	Losing one's intention either immediately before or during a task.	"Immediately forgetting an intention to do something." "Starting to do a task at home and then forgetting what I was about to do." "Forgetting that I have something cooking on the stove."	54	3.96 (1.12)
To do lists	Tasks participants intended to do.	"Jobs I meant to get done – forgetting the letter that I needed to post or to get more milk." "Thinking of something I must do but tend to forget to do it." "Losing track of the things I need to do during the day, particularly the less common ones – forgetting to pay a bill etc."	102	3.88 (1.12)
Autobiographical memories	Memories of one's earlier life.	"Forgetting what I have done over the last week." "I forget details about where we have been or done. It's like looking backwards into grey." "Remember very little of my childhood."	44	3.82 (1.45)
Appointments and upcoming events	Future scheduled events or important days e.g., birthdays.	"Remembering birthdays of all my friends and family." "Forgetting what time meetings are set for." "Remembering dates and appointments in my job."	58	3.81 (1.12)
Non-specific	Unclear or generic responses.	"Instant recall when asked something." "I am aware that my memory was not as sharp as it was a few years ago." "Trying to remember what I forgot."	33	3.73 (1.34)
Other names	Names of things other than people – e.g., book and movie titles, place names.	"Forgetting names of films I have seen." "Sometimes I find it hard to recall a specific bit of information such as the name of a restaurant." "Place names when answering quiz questions."	33	3.71 (1.16)

Code Title	Description	Examples	*n*	*M* (*SD*)
People's names	Names of individuals, either known to the person or not (e.g., celebrities, authors of books).	"Sometimes remembering people's names takes a little while." "Forgetting names of clients and team members." "Always had difficulty with names."	302	3.64 (1.10)
Context	Difficulty remembering the context in which an event occurred.	"Forgetting when I did something – like when I visited a place overseas." "Remembering where I have met people previously." "Forgetting where I have seen or heard information."	14	3.55 (1.51)
Word retrieval	Being able to produce a desired word when wanted – includes "tip of the tongue" experiences.	"Finding a word missing in the middle of the sentence, when it is familiar and often the object of the sentence." "Tip of the tongue syndrome." "Can't find the word I need to describe something."	85	3.55 (1.15)
Train of thought	Losing the thread of one's intentions, often during a conversation.	"I sometimes forget what I was about to say." "Getting partway through a sentence and losing my train of thought." "Remembering something I want to add or say in a conversation if I am not able to say it immediately."	15	3.53 (1.60)
What I needed to buy at the supermarket	Forgetting to buy intended items at the supermarket or a shop.	"Forgetting something on a shopping list that is in my head." "Remembering everything I have to get at a store." "Going to the supermarket and forgetting to get what I went for."	62	3.46 (1.34)
Things I have told others	Not being able to remember whether or that one has already told someone something.	"I have to really think about what I will say in case I said it a little earlier sometimes." "Forgetting at times what I was talking about with friends. I have no recall of what I was saying." "Remembering promises to my children."	21	3.41 (1.23)
To take things with me	Not remembering to take particular items with them when they leave a location.	"Forgetting to take the list drawn up to the supermarket." "I forget to take things I need for work or from work that I will need at home."	13	3.33 (0.98)

Code Title	Description	Examples	*n*	*M* (*SD*)
What I came in here for	Reaching a location (e.g., another room) and not being able to remember why they came.	"Walking into a room and forgetting why I walked in there in the first place." "Forgetting my reason for going to the garage." "Forgetting something I specifically went to a place to get."	81	3.18 (1.08)
Orientation	Difficulty remembering current orienting information such as the date.	"Forgetting which day it is."	6	3.17 (1.33)
Overall			1207	3.62 (1.07)

Following initial category formation and coding, a second rater independently coded the qualitative data (*N* = 1306) according to the definitions provided in Table 4. Agreement was defined as concordance of both raters on the category each semantic unit was assigned to. Initial inter-rater agreement was 93.19%, with Cohen's K = 0.93. Discussion of units where raters disagree on the coding category resulted in changes to the ratings for all remaining units (*n* = 89), with final inter-rater agreement being 100%.

Forgetting names of other people was almost three times more common than any other type of memory difficulty, yet was only moderately distressing in relation to other difficulties. Trouble remembering multiple pieces of information simultaneously, not recognizing people's faces, and forgetting things others have said to a person were the most distressing difficulties overall, while forgetting the current day or date, the reason for entering a room, and not remembering to take needed items when leaving were the least distressing.

Questionnaire Assessment of Memory Difficulties

Descriptive statistics of the distress ratings for questionnaire items are given in Table 5. Means were calculated by taking the average of all ratings for the item between 2 and 7 (ratings of 1 were excluded from calculations as they represented a response of "not at all a problem"). Similar to the spontaneously reported SMCs, remembering other people's names was the most frequently endorsed difficulty on the questionnaire. However, forgetting people's names was also rated as the most distressing difficulty overall, unlike the moderate distress associated with this category under spontaneous reports. Other relatively distressing difficulties were word retrieval and trouble remembering where items were. The least distressing difficulties were completing an action twice by mistake, not recognizing known places, and getting lost in known places.

Table 5. Comparisons of Distress Ratings for Matched Questionnaire Items and Spontaneously Reported Memory Difficulties

Questionnaire Responses			Self-Reports (matching responses only)			*p*	*d*
Item	*n*	*M* (*SD*)	Category	*n*	*M* (*SD*)		
Trouble remembering the names of people you have met.	393	4.23 (1.52)	People's names	256	3.67 (1.09)	<.001*	.42
Trouble thinking of a word that you want to use, e.g., it might be on "on the tip of your tongue"	389	3.84 (1.42)	Word retrieval	73	3.53 (1.17)	<.001*	.24
Trouble remembering where you have put things (e.g., keys, glasses).	344	3.48 (1.43)	Where I have put things	54	3.98 (1.12)	.013	.39
Losing track of what you were doing partway through a task (e.g., walking into another room and forgetting what you went there to do).	360	3.45 (1.22)	What I came in here for	66	3.18 (1.08)	<.001*	.23
Trouble remembering details of what you have been reading (in a newspaper article or book for example)	318	3.44 (1.30)	Content of books or movies	24	4.17 (1.43)	.095	
Deciding to do something in a few minutes' time but then forgetting to do it.	324	3.40 (1.32)	What I was doing	25	3.92 (1.22)	.533	
Trouble remembering details from a conversation or something you were told a few minutes ago.	229	3.31 (1.35)	Things others have told me	37	4.41 (1.36)	.254	
Forgetting what you came to the supermarket/shops to buy.	278	3.20 (1.27)	What I needed to buy at the supermarket	53	3.45 (1.38)	.018	.19
Forgetting what it was that you wanted to say in a conversation.	332	3.20 (1.32)	Train of thought	10	3.00 (1.05)	.004	.17

Questionnaire Responses			Self-Reports (matching responses only)			*p*	*d*
Item	*n*	*M* (*SD*)	Category	*n*	*M* (*SD*)		
Trouble remembering something that happened or that you were told yesterday or a few days ago.	286	3.15 (1.32)					
Trouble remembering when things happened in your life.	234	3.13 (1.35)	Context	4	3.00 (0.82)	.312	
Not recognizing people by sight (could be friends, acquaintances or characters on a TV show for example).	170	3.12 (1.32)	People	8	4.88 (1.36)	.021	1.31
Forgetting to do something that is a departure from your usual routine.	244	3.07 (1.19)	To do lists	8	3.88 (0.83)	.850	
Trouble remembering phone numbers you use often.	234	3.07 (1.31)	Facts	15	4.20 (1.32)	1.00	
Forgetting an important date (such as someone's birthday or an anniversary).	230	3.07 (1.26)	Appointments and upcoming events	28	3.82 (1.22)	1.00	
Trouble remembering how to do something new (e.g., how to operate a new gadget or device).	266	3.00 (1.26)	Procedural	7	4.43 (1.27)	1.00	
Not keeping up to date with correspondences or paying bills on time.	199	2.95 (1.24)					
Telling someone something (e.g., a story or joke) you have already told them, or asking the same question several times.	243	2.91 (1.14)	Things I have told others	5	2.80 (1.10)	.230	
Forgetting to pass on a message.	244	2.90 (1.07)					
Forgetting to do routine tasks or chores.	175	2.89 (1.12)	To do lists[a]	8	3.75 (1.04)	.516	
Forgetting appointments.	201	2.89 (1.17)	Appointments and upcoming events[a]	25	4.04 (1.14)	.376	
Getting lost on a journey or walk you have often been on.	57	2.74 (1.30)					
Not recognizing places even though you have been to them before.	116	2.70 (0.95)					
Doing something twice by mistake (e.g., taking medication, feeding a pet).	89	2.62 (0.85)	Completed actions	0	-	[b]	

a. Category repeated due to encompassing more than one questionnaire item.
b. No t-test computed due to elimination of matching responses once strict coding applied to category.
* significant at corrected $\alpha < .05$.
Note. Five specific categories (other names, autobiographical memories, orientation, multiple things at once, and to take things with me) did not match any questionnaire item and are not included in this table.

Comparison of Assessment Methods

As above, descriptive and inferential statistics presented here exclude any spontaneously reported complaints or examples endorsed with a distress rating of 1 (i.e., “not at all a problem”), in order to reflect only those memory difficulties that cause some level of distress.

Paired samples t-tests revealed that participants reported significantly fewer complaints ($t(379) = 45.09$, $p < .001$, $d = 2.96$) under spontaneous report ($M = 2.81$, $SD = 1.42$) than questionnaire methods ($M = 14.69$, $SD = 5.49$), but that they assigned significantly higher distress ratings ($t(379) = 9.42$, $p < .001$, $d = 0.45$) to their spontaneously reported difficulties ($M = 3.62$, $SD = 1.07$) than to the questionnaire items ($M = 3.20$, $SD = 0.77$) overall.

In order to assess potential differences between distress ratings for individual memory difficulties across the two assessment methods, a further ‘strict coding’ method was applied to qualitative data, so that questionnaire items were matched with (where appropriate) corresponding codes from the spontaneously reported SMCs, and then compared to those responses from each spontaneously reported category that qualitatively matched the nature of the questionnaire item. For example, the questionnaire item “Forgetting an important date (such as someone’s birthday or anniversary)” was matched to the spontaneous report category “Appointments and upcoming events”, and compared to only the responses in that category which did actually refer to forgetting an important date (i.e., excluding responses that did not refer to dates but still fell within the “Appointments and upcoming events” category, such as “what time my daughter’s hockey game is this week”). This resulted in fewer spontaneous reports of particular SMCs than were originally present in each category under the ‘loose coding’ method from Table 4. Strict coding matches, along with corresponding descriptive statistics, and results of paired samples t-tests for each item-category pair are displayed in Table 5.

Correspondence between spontaneously reported SMCs and questionnaire items was moderate, but revealed many instances of either redundancy or lack of comprehensiveness in the questionnaire items. Areas of potential redundancy in questionnaire assessment were demonstrated by five questionnaire items ("Trouble remembering something that happened or that you were told yesterday or a few days ago", "Not keeping up to date with correspondences or paying bills on time", "Forgetting to pass on a message", "Getting lost on a journey or walk you have often been on", and "Not recognizing places even though you have been to them before") which did not match any category of spontaneously reported memory difficulty, and by two categories ("Appointments" and "To do lists") which matched two questionnaire items each. Five spontaneous report categories ("Multiple things at once", "Autobiographical memories", "Other names", "To take things with me", and "Orientation") did not match any questionnaire items, and consequently may represent areas that are overlooked by traditional questionnaire assessment.

Even in those categories which did correspond to a particular questionnaire item, often the questionnaire item was much more specific and only directly matched a subset of the responses in that category (e.g., "Trouble remembering details from a conversation or something you were told a few minutes ago" in the category "Things others have told me"). Table 5 shows three pairs of categories and questionnaire items in which the distress ratings were significantly different across the two assessment methods after applying the Holm-Bonferroni correction for multiple comparisons (Holm, 1979). These pairs included those where correspondence between category and item was high (e.g., "People's names" category and "Trouble remembering the names of people you have met" item). In all three cases participants reported greater distress when the difficulty was assessed via a questionnaire item than when the same difficulty was spontaneously reported.

Discussion

SMCs and their associated distress were assessed by both spontaneous report and questionnaire methods in a sample of adults aged 40 and above. Consistent with expectations, participants spontaneously reported fewer SMCs overall than they endorsed on a questionnaire. Similarly, individual SMCs tended to be endorsed more often on the questionnaire than they were spontaneously reported. Apolinario et al. (2013) suggest that this difference is explained by the effect of cueing on responses, whereby people tend to report those SMCs which are most salient when they are questioned openly about memory difficulties, but providing examples of potential SMCs in a questionnaire also acts as a reminder of other SMCs that they have experienced but were not sufficiently distressing to warrant a spontaneous report.

Existing methods of SMC assessment use either structured questionnaires or simple open-ended question assessment, but little is known about the variation in responses these different methods might elicit (Abdulrab & Heun, 2008; Apolinario et al., 2013). Here, a number of differences between spontaneous report and questionnaire assessment were found. Firstly, the kinds of SMCs that participants reported spontaneously were much more varied than those SMCs they endorsed on a questionnaire. Even when questionnaire items corresponded to categories of spontaneously reported SMCs, the specific examples of SMCs given on a questionnaire often only represented a small subset of spontaneously reported SMCs. Secondly, participants also reported five SMCs that were not captured by the questionnaire – including the single most distressing spontaneously reported SMC (remembering multiple things at once). Thus questionnaire assessment did not capture the full range of SMCs that participants reported, and in some cases failed to assess SMCs that were the most distressing.

Conversely, other questionnaire items such as “Forgetting to pass on a message”, “Not recognizing places even though you have been to them before”, and “Not keeping up to date with correspondences or paying bills on time" were not reflected in participants' spontaneous reports, and likely demonstrate areas which could be omitted from future assessment in the interests of retaining focus on SMCs which people find most distressing.

The degree of distress reported for each kind of SMC also varied between assessment methods, and did not necessarily mirror the frequency with which each SMC was endorsed. Participants rated their spontaneously reported SMCs as more distressing overall than those they endorsed on the questionnaire. Given that the SMCs participants report spontaneously are likely to be those which are most salient to them, understandably these also tend to be those which are most distressing. SMCs endorsed on a questionnaire are instead more likely to represent difficulties that do occur but are not as distressing - and therefore not as salient for participants and require cueing in order for them to be reported (see also Apolinario et al., 2013).

In contrast to these overall trends, comparisons of individual SMCs across assessment methods revealed the opposite pattern - in all significant cases, distress ratings were higher for questionnaire items than for their corresponding categories of spontaneously reported SMCs. One explanation for this pattern is context effects. While participants tend to endorse a large number of the SMCs mentioned in the questionnaire, they do so to a small degree and hence give a large number of low distress ratings, making for a low average distress rating across all questionnaire items. When asked to spontaneously report their SMCs, they tend to only report those difficulties that are most distressing, and therefore give relatively high distress ratings. Hence the overall distress ratings are on average higher for spontaneously reported difficulties than questionnaire examples. However, for those SMCs which are both spontaneously reported by a participant and included on the questionnaire, their distress rating is likely to be higher when it occurs in a questionnaire context and is surrounded by a number of relatively minor difficulties, causing participants to interpret a given distressing SMC as relatively more distressing than when it was spontaneously reported and in the context of other similarly distressing SMCs.

Alternatively, differences in distress ratings might reflect semantic differences between the specific questionnaire item and the broader coded category. However this is less likely due to the stricter coding scheme used for comparative analyses, whereby only spontaneously reported SMCs that directly matched the questionnaire item were included in analysis, thus excluding other responses which also fell under the same coding category but did not necessarily match the questionnaire item.

Another potential explanation is the order in which the survey was presented –the questionnaire was always presented after the spontaneous report section, and so consistent increases in distress ratings across time may explain the differences between assessment methods. This fixed sequence was necessary in order to prevent potential cueing effects during the spontaneous report section.

Spontaneously reported SMCs which were most distressing for this sample – “Multiple things at once”, “Things others have told me”, “People”, “Facts”, and “Procedural” – initially appear to have little in common. However when considered in context of the least distressing difficulties – “Orientation”, “What I came in here for”, “To take things with me”, “Things I have told others”, and “What I needed to buy at the supermarket” - one explanation relates to the consequences of each memory difficulty and the availability of corrective strategies. Previous research has found that those SMCs which have the greatest functional impact cause the greatest distress (Newson & Kemps, 2006), and that perceived severity of the consequences of SMCs influences how distressing those SMCs were (Hurt et al., 2010). Consistent with these explanations, here the least distressing difficulties tended to be ones which could be relatively easily rectified – for example by looking up today’s date (“Orientation”) or retracing one’s steps (“What I came in here for”), and indeed participants often mentioned these strategies in their responses. The consequences of these least distressing difficulties are also relatively minor - e.g., re-visiting the supermarket for an item, or asking someone else whether you have already told them something. In contrast, the consequences of the most distressing difficulties can be conceived of as more significant for occupational and/or social functioning. For example, not recognizing someone you know or forgetting what someone else has told you can be socially embarrassing and damaging to relationships, and trouble remembering multiple things simultaneously could influence someone's ability to perform at a necessary level at work or home. Furthermore, compensatory strategies for these kinds of difficulties are relatively more difficult to implement and indeed were rarely mentioned by participants.

How the functional impact of various SMCs influences the subjective distress they cause can also be considered in terms of age-related differences that were found during preliminary analyses. Middle-aged adults rated the SMCs they reported (under both assessment methods) as more distressing than older adults did, and adults aged 40-59 also tended to rate themselves as more stressed than adults aged 70 and above did. One explanation consistent with all of these results is that the daily demands of these age groups differs and consequently so does the functional impact of their SMCs (see also Apolinario et al., 2013). Middle-aged adults are more stressed and therefore SMCs are likely to impact on their occupational functioning to a greater extent than it would for older adults whose lifestyle may not be as stressful and therefore they are more able to cope with the impact of SMCs. On the other hand, middle-aged adults may experience greater stress in part because of the greater amount of distress their SMCs cause them.

Implications

This study was the first to directly compare two methods of SMC assessment using a comprehensive questionnaire. Results support the use of open-ended questioning methods over that of structured questionnaires, with implications for SMC assessment being that spontaneous, uncued reports of SMCs have merit as a basis for clinical investigation. Instead of relying on prescriptive questionnaires (which can overemphasize SMCs that are less distressing), clinicians can gather more meaningful information by paying attention to a person's spontaneously reported complaints. This method of assessment has three main advantages: firstly, it retains focus on those SMCs that have the greatest subjective impact for an individual. Secondly, unprompted reporting of SMCs has also been shown to have greater value in predicting objective memory impairment than questionnaire assessment (Mattos et al., 2003), and therefore may hold further value in the assessment of cognitive disorders. Thirdly, by attending to and validating subjectively distressing memory complaints, clinicians may be able to encourage their disclosure (and consequent treatment) even though SMCs are not often the reason for seeking medical attention (Begum et al., 2012).

Despite the advantages of open-ended assessment of SMCs, questionnaires remain the most comprehensive method for assessing the presence or absence of particular complaints. This can be particularly useful for those complaints that may indicate a need for further investigation (Amariglio, Townsend, Grodstein, Sperling, & Rentz, 2011), however questionnaire methods might be best used only after eliciting spontaneously reported SMCs, in order to prevent any cueing effects and retain focus on the most subjectively distressing complaints. Appending a questionnaire to open-ended assessment of SMCs may not always be necessary either, as qualitative data gathered here suggested that participants still tended to report those SMCs that were most distressing to them, even when not cued by particular examples of SMCs (as on a questionnaire).

Abdulrab and Heun (2008) have suggested that different methods of SMC assessment might be one factor that underlies differing results concerning the relationship between SMCs and objective memory impairment. Implications from the current study support this conclusion, finding evidence that different methods do elicit both different rates of endorsement of various types of SMCs, as well as different ratings of subjective distress associated with these SMCs. Thus implications for further research are to be mindful of how

SMCs are assessed, and to take this into account when drawing conclusions about links between subjective and objective memory functioning.

This study also highlights the considerable impact that SMCs have for middle-aged adults (as does previous work by Mattos et al., 2003). While other research has found SMCs to be more prevalent among older adults (e.g., Gino et al., 2010), the current results suggest that the distress associated with SMCs is at least as great (if not greater) for middle-aged adults. The authors note anecdotal evidence from their clinical work that suggests SMCs might have particular significance for middle-aged adults because they can impact their social and occupational functioning. Consequently, clinicians may be able to help alleviate SMC-related distress in middle-aged adults through discussion of lifestyle habits that may contribute to their distress, and/or simple psychoeducation about how memory and other cognitive functions change with ageing.

Future Research

Given the implications that using questionnaires as a first-line method of assessment may not be most meaningful or helpful to those with SMCs, the next steps are to develop and validate methods of assessing SMCs which retain the detail and comprehensiveness provided by existing questionnaires, while still retaining emphasis on participant's spontaneous reports. For example, gathering non-prompted information about a person's most distressing SMCs and then prompting them for further detail and information about the impact of such SMCs on daily life might better assess SMCs in detail while remaining centered on those which individuals report as most distressing.

A further step is to explore which kinds of SMCs might be of greatest predictive value in targeting and pre-empting cognitive disorders. With such information, spontaneously reported SMCs can be used to predict future prognoses and help individuals access appropriate services, without cueing certain SMCs and risking spurious or inflated reporting of the most concerning SMCs. Evidence for age-related differences in the types of SMCs reported (Ginó et al., 2010) and an association between particular SMCs and cognitive impairment (Amariglio et al., 2011) has already been documented and could also be informative in this regard.

Finally, investigation into exactly how conclusions about the relationship between SMCs and objective memory impairment might differ on the basis of SMC assessment methods would be warranted. Given that reports do differ across assessment methods, future work incorporating a measure of objective memory performance would be helpful in delineating the impact of assessment methods on conclusions drawn about SMCs and objective memory. Indeed Mattos et al. (2003) have conducted preliminary work in this area, and found evidence that spontaneous reports of SMCs was more predictive of objective memory performance than SMCs as assessed by a questionnaire.

Limitations

The construction of the questionnaire items in this study present some potential limitations to the results. Not using the items from existing questionnaires in their *original* form means that any comparisons between these results and those of other studies might in part be due to differences in the wording of particular items. Comparisons between spontaneously reported categories of SMCs and corresponding questionnaire items were also limited by the reduced sample sizes of various categories, resulting in only three pairs demonstrating a significant difference. It is likely that with greater sample sizes for spontaneously reported SMC categories other pairs might also have reached significance and provided further evidence of greater distress ratings on questionnaire items than spontaneously reported categories.

The scale used for distress ratings may also have been interpreted differently in the two methods of assessment, despite being ostensibly identical. The influence of context effects on the distress ratings of particular SMCs suggests that participants could have interpreted the scale differently, and in turn this could detract from the meaning of any comparisons of distress ratings. Perhaps comparisons between distress ratings for spontaneously reported SMCs might be more accurately compared to endorsement rates (frequencies) of questionnaire items rather than their distress ratings. In addition, differential interpretation of the instruction to rate “how much of a problem” each SMC was could have led to rating how much of a *memory* problem or how much of a *life* problem they were.

Certain assumptions were also made during the research that, if incorrect, could also detract from or invalidate any conclusions drawn. Firstly, separating spontaneous reports of SMCs into individual semantic units and assigning the distress rating to each of these units assumes that the participant would have assigned each SMC unit that rating, rather than it referring to one SMC in particular. Secondly, the coding categories constructed are open to interpretation and may have been different depending on the focus of the research. For example, perhaps domain of impact (e.g., social, occupational) may have been a more meaningful conceptualization of spontaneously reported SMC categories.

Summary

This study is one of the first to directly compare how reports of SMCs differ as a result of two different methods of assessment – spontaneous reports and a questionnaire. Results suggested that questionnaire assessment potentially overlooks a number of SMCs that can cause considerable distress for middle-aged and older adults. Furthermore, questionnaires can contain items that are of little concern according to spontaneous reports of SMCs. While people may report fewer SMCs spontaneously than they will endorse on a questionnaire, those they do report tend to be those which cause most distress. Accordingly, targeting spontaneously reported SMCs for intervention is an appropriate way to alleviate distress. Questionnaires are better used to ascertain the presence of specific complaints, and require careful consideration of which SMCs should comprise their items.

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CHAPTER 6

INFLUENCE OF ASSESSMENT METHODS ON SUBJECTIVE AND OBJECTIVE MEMORY IMPAIRMENT

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Abstract

Evidence regarding the relationship between subjective memory complaints (SMCs) and objective memory functioning remains mixed, and assessment methods may underlie this inconsistency (Burmester, Leathem, & Merrick, 2015; Reid & MacLullich, 2006). Ninety-four participants aged 40 and above completed two measures of SMCs (open-ended self-reports, and a questionnaire) and memory tests (Rey Auditory Verbal Learning Test and Rey Complex Figure Test). Canonical correlation analysis showed no significant associations between any measures of memory and SMCs, regardless of the assessment method. Possible explanations for this result, and the influence of study limitations, are discussed.

Introduction

Subjective memory complaints (SMCs) are a significant cause of distress for many adults as they age, and are often interpreted as an indicator of age-related declines in memory functioning (Paradise, Glozier, Naismith, Davenport, & Hickie, 2011). However, research examining the link between SMCs and objective measures of memory impairment and decline has continued to produce mixed results. For example, some studies find that SMCs and memory performance are significantly associated (e.g., Calabria et al., 2011), while others find no such evidence (e.g., Buckley et al., 2013).

Many find SMCs to be a better indicator of affective factors such as depressive or anxiety symptoms rather than actual memory functioning (e.g., Balash et al., 2013; Chin, Oh, Seo, & Na, 2014), while others argue that SMCs predict memory functioning even when these factors are taken into account (e.g., Amariglio, Townsend, Grodstein, Sperling, & Rentz, 2011; Benito-León, Mitchell, Vega, & Bermejo-Pareja, 2010; Gates, Valenzuela, Sachdev, & Singh, 2014; Rouch et al., 2008). Another suggested possibility is that SMCs predict memory performance only in certain groups, such as older population-based samples (Jonker, Geerlings, & Schmand, 2000; Merema, Speelman, Kaczmarek, & Foster, 2012), women (Juncos-Rabadan et al., 2012), or those with significant levels of memory impairment (Park et al., 2007).

Reviews of this literature (Jonker et al., 2000; Reid & MacLullich, 2006, Crumley, Stetler, & Horhota, 2014) have suggested the inconsistency of results might be attributable to methodological factors such as sample selection and widespread variation in the methods used to measure both SMCs and memory performance. In particular, measures of SMCs used in reviewed studies were often very brief (sometimes constituting a single question with a yes/no response), not validated, and seemingly arbitrary. Recent work has shown that the method of SMC assessment has a significant impact on the types, number, and associated distress ratings of SMCs reported by participants (Burmester, Leathem, & Merrick, 2015), with spontaneously reported SMCs appearing to be a more accurate reflection of a participant's concerns than their responses to a questionnaire which lists examples of SMCs. However, no work has yet directly examined how these differently elicited SMC reports relate to the same participants' scores on objective memory tests.

If assessment methods are in part responsible for the wide variation in results to date, then the statistical relationship between SMCs and memory performance is expected to differ as a function of the measures used to quantify each variable. Burmester et al. (2015) suggest that SMCs which are spontaneously generated by participants reflect insights into their cognitive functioning which are not confounded by contextual effects (such as priming through asking about specific examples of SMCs), and therefore SMCs as assessed by spontaneous reports might be expected to demonstrate stronger relationships with measures of memory functioning. However, other work would predict that SMCs and actual performance would not be related at all, either because the subtle changes in cognitive functioning that trigger SMCs are not reflected in objective test scores (Jonker et al., 2000), because memory performance does not necessarily correlate with the insight into one's functioning that SMCs represent (Jungwirth et al., 2009), or because affective variables have a confounding influence (Buckley et al., 2013; Rickenbach, Agrigoroaei, & Lachman, 2015).

The current study aims to assess the impact of SMC assessment method on the relationship between SMCs and memory performance by examining the associations of different measures of SMCs (as spontaneously reported and as responses to a questionnaire) with participants' scores on formal memory tests. It is hypothesized that relationships between SMCs and memory performance will be strongest when SMCs are assessed via spontaneous report measures. Given that SMCs have been shown to increase from middle-age onwards (Ponds, van Boxtel, & Jolles, 2000), this study includes participants from ages 40 and above.

Method

Participants

Ninety-four people (62.8% women; 37.2% men) aged 40 and above completed a survey assessing SMCs and later underwent cognitive testing (either in a research office, 90.4%, or at home) to assess memory functioning. Other demographic characteristics of the sample are displayed in Table 6.

Table 6. Percentage of Participants in Each Demographic Category

Variable	Category	% of sample
Age	40-44	10.6
	45-49	6.4
	50-54	13.8
	55-59	5.3
	60-64	6.4
	65-69	10.6
	70-74	21.3
	75-79	10.6
	80-84	11.7
	85+	3.3
Ethnicity	New Zealand European	85.1
	Māori	3.2
	Asian	1.1
	Other	10.6
Education	High school attendance	5.4
	School Certificate	9.8
	University Entrance	8.7
	Tertiary certificate/diploma	26.1
	Bachelor’s degree	22.8
	Postgraduate qualification	27.2

Measures

Survey. In the first section of the survey, covering demographic details, participants indicated their age bracket (coded as 1 = 40-44, 2 = 45-49, 3 = 50-54, 4 = 55-59, 5 = 60-64, 6 = 65-69, 7 = 70-74, 8 = 75-79, 9 = 80-84, and 10 = 85 and above), gender, ethnicity, and highest level of education (where 1 = high school attendance, 2 = school certificate, 3 = university entrance qualification, 4 = tertiary certificate or diploma, 5 = bachelor's degree, and 6 = postgraduate qualification).

The second section of the survey assessed spontaneously reported SMCs. Participants were asked to describe up to seven memory difficulties they experienced in daily life, and rate the distress associated with each of them. The third section consisted of a structured questionnaire that asked participants to rate the distress associated with each of 24 given SMCs (e.g., "trouble remembering the names of people you have met"). Both measures used a 7-point Likert scale to rate distress associated with each SMC, where 1 represented "not at all a problem", 4 "sometimes a problem", and 7 "one of my biggest problems" (see Burmester, Leathem, & Merrick, 2015, for further details of this survey).

Neuropsychological testing. Participants completed trials 1-7 of the Rey Auditory Verbal Learning Test (RAVLT; Strauss, Sherman, & Spreen, 2006) and the immediate and delayed recall trials of the Rey Complex Figure Test (RCFT; Meyers & Meyers, 1995). Raw scores for each trial were converted to z-scores according to age- and gender-specific norms from Strauss et al. (2006) for the RAVLT, and Meyers and Meyers (1995) for the RCFT.

Procedure

Participants completed the survey in either online or hard copy format, where spontaneous reports of SMCs were always elicited first, followed by completion of the structured questionnaire assessment. Objective memory assessments were administered between nine and eleven months after the survey, as part of a larger test battery. Trials 1-5, B, and 6 of the RAVLT were always presented first, followed by the 'copy' and 'immediate recall’ trials of the RCFT, then trial 7 of the AVLT (approximately 20 minutes after trial 1 of the AVLT), and finally the ‘delayed recall’ trial of the RCFT (approximately 30 minutes after the copy trial of the RCFT).

Data Analysis

Qualitative responses to the open-ended assessment of SMCs were coded by the first author using content analysis methods (Krippendorf, 2013) and then checked by a second rater for category consistency. Initial inter-rater agreement was 93.19%, with Cohen’s kappa $\kappa = 0.93$. After discussion of disagreements final inter-rater agreement was 100%. Further details of this procedure are provided in Burmester et al. (2015).

All quantitative data was analyzed using the SPSS software package (v23). First, multivariate analyses of variance were used to assess differences due to potential confounding variables. Then, associations between various measures of SMCs and memory functioning were analyzed using canonical correlation procedures as outlined in Tabachnick and Fidell (2013). Canonical correlation is the most appropriate statistical procedure for analysing the relationships between two sets of inter-related variables, and highlighting the variables from each set that contribute most to a relationship between the two sets. A sample size equivalent to ten cases per independent variable is recommended, which the current study exceeds with a maximum of six variables in the objective memory set and a total of 94 participants.

Results

Preliminary Analyses

Multivariate analyses of variance (with Bonferroni correction for multiple analyses giving $\alpha = .0125$) were performed on the objective memory measures to first assess the extent to which demographic factors might account for differences in performance. There were no significant differences in memory scores between participants on the basis of ethnicity ($p = .124$), education ($p = .198$), gender ($p = .062$), or age ($p = .067$), so these variables were not incorporated in any subsequent analyses.

Data Screening

Following the procedures for canonical correlation outlined in Tabachnick and Fidell (2013), data was first screened for missing values. Seven participants were missing data for the number and associated distress of their spontaneously reported SMCs. These data points were not imputed because they represented meaningful values (i.e., participants with no spontaneously reported SMCs).

Univariate outliers were also retained as they represented important data points that may have signalled theoretically important relationships. Inspection of skewness and kurtosis values and normal Q-Q plots for each variable showed no significant evidence of non-normal distributions, so no data transformations were applied. Multivariate normality was assumed due to the presence of univariate normality for all variables (Tabachnick & Fidell, 2013). A scatterplot matrix of all possible bivariate combinations of variables showed no evidence of non-linearity or heteroscedasticity, or multivariate outliers that warranted exclusion. Assumptions regarding multicollinearity were met, with no bivariate correlations exceeding 0.9.

Canonical Correlation

A canonical correlation analysis was conducted between the four subjective memory variables (number of spontaneously reported SMCs, number of questionnaire items endorsed, mean reported distress associated with each spontaneously reported SMC, and mean reported distress associated with each questionnaire item) and the six objective memory variables (scores across AVLT trials 1-5, B, 6, and 7, and RCFT immediate and delayed trials). The analysis yielded four functions with canonical correlations of .437 (24% overlapping variance), .277 (8% overlapping variance), .240 (6% overlapping variance), and .034 (0.1% overlapping variance). The full model across all functions was not statistically significant using a Wilks' $\lambda = .70$ criterion, $F(24, 276.81) = 1.23$, $p = .217$.

Discussion

Previous reviews of literature examining the link between SMCs and memory performance have highlighted considerable inconsistency among results, and suggested that varied methods of assessing SMCs might explain such discrepancies (Jonker et al., 2000; Reid & MacLullich, 2006, Crumley et al., 2014). This study aimed to test this assertion by examining how SMCs (as assessed via two methods, an open-ended spontaneous report and a structured questionnaire) related to scores on tests of verbal and visual memory in a within-subjects design. A canonical correlation analysis found no significant associations between any measures of memory performance and SMCs, regardless of which method was used to assess SMCs. This result is surprising given previous suggestions that assessment methods could explain some variation in findings regarding the relationship between subjective and objective memory (Jonker et al., 2000; Reid & MacLullich, 2006, Crumley et al., 2014). Despite the use of an exploratory statistical technique appropriate for this data, adequate sample size, and clear rationale, the absence of any significant association between the SMC and memory performance measures suggests that at least in this instance, subjective and objective memory functioning are not related, and SMCs were not a reliable indicator of objective performance.

A number of other alternative explanations are also possible. Firstly, SMCs may not reflect insight into actual cognitive functioning (as already reported by Jungwirth et al., 2009). Secondly, SMCs might reflect insight into declines in objective memory functioning, but these declines are too subtle to be detected on objective tests (Jonker et al., 2000). Thirdly, SMCs might instead be more closely related to other non-memory aspects of cognition. For example, previous research has found that SMCs are associated with difficulties of inhibition (Potter & Hartman, 2006), echoing theoretical accounts of cognitive ageing whereby cognitive mechanisms of inhibition (Hasher & Zacks, 1988) underlie age-related declines in other cognitive functions. Similarly, SMCs may reflect declines in the speed of retrieval rather than outright failures, consistent with processing speed accounts of cognitive ageing (Salthouse, 1996). Finally, a relationship between SMCs and memory performance may only exist for certain subgroups of the population sampled. For example, middle-aged adults are less likely to display objective memory impairment than older adults, and so may not exhibit any subjective-objective memory association. However, it should be noted here that no significant differences in any of the memory test scores were noted on the basis of age or other demographic variables, suggesting that these differences were not present in this sample.

Limitations

The result observed here could also be attributed to limitations of the study. Firstly, the use of canonical correlation techniques has noted limitations due to the generalist nature of the analysis (Tabachnick & Fidell, 2013) - for example, assumption of linear relationships and vulnerability to effects of variable choice. However, the exploratory goals of this research question and the grouped nature of the variables meant that canonical correlation was the most appropriate choice for analysis. Similarly, the size of the sample included here was adequate in order to conduct canonical correlation (Tabachnick & Fidell, 2013), however given the small size of the correlation between subjective and objective memory measures ($r = .13$; Burmester, Leathem, & Merrick, 2016), greater statistical power may be needed in order to identify the specific influence of assessment methods on this effect.

Secondly, previous conclusions that SMCs are more likely to predict future decline in memory performance rather than current deficits (Jonker et al., 2000; Reid & MacLullich, 2006) could not be addressed here due to the use of cross-sectional data only, and longitudinal examinations of this relationship would be the next logical step in this line of research. Related to this point is the nine- to eleven- month time lag between collecting data on SMCs and that on memory performance. Although such delays are not methodologically ideal, they are not unprecedented (e.g., Ponds et al., 2000), and may lead to more conservative estimates of the relationship between SMCs and memory performance than if the variables were assessed closer together in time.

Thirdly, other important variables that have also been highlighted in previous work, such as depressive and anxiety symptoms, were not examined here and thus their influence on the findings was not accounted for. However, many studies have also suggested that the link between SMCs and memory performance is (at least somewhat) independent of affective symptoms (Amariglio et al., 2011; Benito-León et al., 2010; Gates et al., 2014; Rouch et al., 2008; Snitz et al., 2012). Explorations of the influence of these variables on the findings observed here should further explicate this relationship.

Conclusion

This study was the first to explicitly compare how differences in SMC assessment methods relate to objectively detected memory performance. Despite the adequate sample size and clear rationale for this analysis, a canonical correlation between four measures of SMCs and six of memory performance showed no significant relationships between the variable groups. This result could be due to limitations of statistical power or cross-sectional design, reflect a genuine lack of relationship between the two variables, or insensitivity to other variables such as affective factors or non-memory cognitive functions. Further research is recommended in order to explicate the influence of these factors, and to explore the relationship between SMCs and memory performance in a larger sample.

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CHAPTER 7

INTERACTION OF COGNITIVE AND AFFECTIVE FACTORS IN EXPLAINING SUBJECTIVE MEMORY COMPLAINTS

This chapter is currently under review for possible publication by *Aging, Neuropsychology and Cognition*.

Abstract

Previous studies investigating the relationship between subjective memory complaints (SMCs) and objectively measured memory functioning in ageing have produced mixed results, meaning that the aetiology of SMCs is not well understood. This study investigates an aetiological model of SMCs based on more established relationships between SMCs and affective symptoms, as well as theories of cognitive ageing. Ninety-four participants aged 40 and above completed a survey assessing SMCs via both open-ended and questionnaire assessments, and subsequently underwent neuropsychological testing in the domains of memory, executive functioning, processing speed, affect, and other covariates. Moderated regression analysis showed that when assessed as the number of memory difficulties endorsed on a questionnaire, SMCs increased proportionally to depressive symptoms. For participants with relatively high levels of depressive symptoms, SMCs were inversely related to processing speed scores. Results offered partial support for the aetiological model and suggest that the interaction of cognitive and affective factors is important in understanding SMCs. These findings have implications for which interventions are likely to be helpful in addressing SMCs, as well as the types of SMC measures which offer greatest clinical and research value.

Introduction

Subjective memory complaints (SMCs) are a commonly reported problem related to ageing. They cause significant distress for many, especially when they are interpreted as indicators of age-related declines in memory functioning or cognitive diseases associated with ageing (e.g., Alzheimer's dementia; Begum et al., 2012; Hurt, Burns, & Barrowclough, 2011). However, research evidence regarding the association between SMCs and objectively assessed memory performance is mixed. Recent meta-analyses found the average association between SMCs and actual memory performance was small but significant, with greater severity of SMCs being related to poorer objective performance (Burmester, Leathem, & Merrick, 2016; Crumley, Stetler, & Horhota, 2014). Reasons for the large variability in findings have been attributed to a number of possible causes, including cognitive, psychological, and methodological factors (Brigola et al., 2015; Burmester et al., 2016; Reid & MacLullich, 2006; Vogel, Salem, Andersen, & Waldemar, 2016).

The association between SMCs and affective factors is more established (Burmester et al., 2016). Numerous studies show links between SMCs and depression (e.g., Açikgöz et al., 2014; Balash et al., 2013; Cooper et al., 2011), sometimes concluding that SMCs are solely (or at least primarily) due to depressive symptoms and not cognitive factors (e.g., Buckley et al., 2013; Yates et al., 2015). Other affective components such as anxiety are also linked to SMCs, both as dynamic state variables (Elfgren, Gustafson, Vestberg, & Passant, 2010; Wilkes, Wilson, Woodard, & Calamari, 2013) and more stable personality traits such as neuroticism (Merema, Speelman, Foster, & Kaczmarek, 2013) and anxiety sensitivity (Dux et al., 2008). Possible mechanisms by which affect influences SMCs include increased salience of everyday memory difficulties due to the negative cognitive bias associated with depression and anxiety; direct manifestation of cognitive symptoms of depression or anxiety; or mutual causality whereby both depressive symptoms and SMCs are triggered by age-related cognitive declines.

Investigations of cognitive and affective variables concurrently suggest that they interact to produce SMCs. For example, Dux et al. (2008) found a variety of affective variables moderated the relationship between SMCs and objective memory performance, where greater levels of depression and anxiety-related symptoms were related to greater discrepancies between subjective and objective memory functioning. Other studies also suggest SMCs reflect both actual cognitive performance and depressive symptoms (Chin, Oh, Seo, & Na, 2014; Hülür, Hertzog, Pearman, Ram, & Gerstorf, 2014), and that predictors of SMCs differ depending on depressive symptoms (Benito-León, Mitchell, Vega, & Bermejo-Pareja, 2010).

While findings are mixed regarding the relationship of SMCs to actual memory functioning, there are suggestions from the cognitive ageing literature that SMCs might be related to other aspects of cognition as well. For example, Salthouse's (1996) theory of cognitive ageing proposes that declines in processing speed underlie changes in all other cognitive functions as well (including memory). Evidence also suggests that age-related declines in processing speed are linked to functional and subjective difficulties – for example, SMCs are cross-sectionally associated with poorer processing speed (Mol, van Boxtel, Willems, & Jolles, 2006), as are other measures of functional ability (Wahl, Schmitt, Danner, & Coppin, 2010). Older adults with SMCs are more likely to show a decline in processing speed over the following five years than those who do not initially report SMCs, and those who display patterns of decline in processing speed also experience the greatest functional impairments in daily living (Lin, Chen, Vance, & Mapstone, 2013).

Alternative theories of cognitive ageing highlight various aspects of executive functioning as important factors underlying a variety of cognitive changes with age. For example, reduced ability to inhibit irrelevant information can explain many age-related cognitive difficulties such as problems with memory and attention (Hasher & Zacks, 1988), and diminished problem-solving abilities explain the greater recruitment with age of frontal lobe areas in cognitive tasks (Luszcz, 2011). Executive functioning abilities are inversely correlated with SMCs (Mascherek, Zimprich, Rupprecht, & Lang, 2011; Potter & Hartman, 2006; Rouch et al., 2008), and may reflect incidents in which an SMC has not been effectively addressed via compensation strategies (Bouazzaoui et al., 2010; Hasher & Zacks, 1988). Further, the greatest explanatory power for cognitive ageing comes from models which include both processing speed and executive functioning components. These models often show that each component contributes unique value to predictions of SMCs (Albinet, Boucard, Bouquet, & Audiffren, 2012; Baudouin, Clarys, Vanneste, & Isingrini, 2009).

As well as cognitive and affective variables, previous work has suggested that the method of assessing SMCs can influence their observed relationships with other variables and may account for discrepant results (Burmester, Leathem, & Merrick, 2015; Rabin et al., 2015; Vogel et al., 2016). SMCs may only relate to objective performance when the two measures have highly congruent content (e.g., subjective and objective measures of medication adherence; Hertzog, Park, Morrell, & Martin, 2000) or when they are assessed by interview methods rather than a questionnaire (Mattos et al., 2003). SMCs and objective memory performance may also exhibit different relationships for different subgroups of participants (Rickenbach, Agrigoroaei, & Lachman, 2015).

The Current Study

Where previous work has examined a limited number of factors in explaining the aetiology of SMCs, this study explores a more comprehensive model of SMCs that incorporates cognitive, affective and measurement factors. Specifically, it is proposed that SMCs are a product of affective symptoms (anxiety and depression), and that this effect is moderated by normal age-related cognitive declines in processing speed and/or executive functioning rather than memory such that the relationship between cognitive abilities and SMCs is expected to be strongest for those individuals with the greatest levels of affective symptoms. Figure 7 illustrates this model.

Multiple measures of SMCs were used here in order to assess how different types of measures influence the relationship between SMCs and other factors. This study also includes both middle-aged and older participants, as SMCs have been shown to increase from age 40 onwards (Ponds, van Boxtel, & Jolles, 2000).

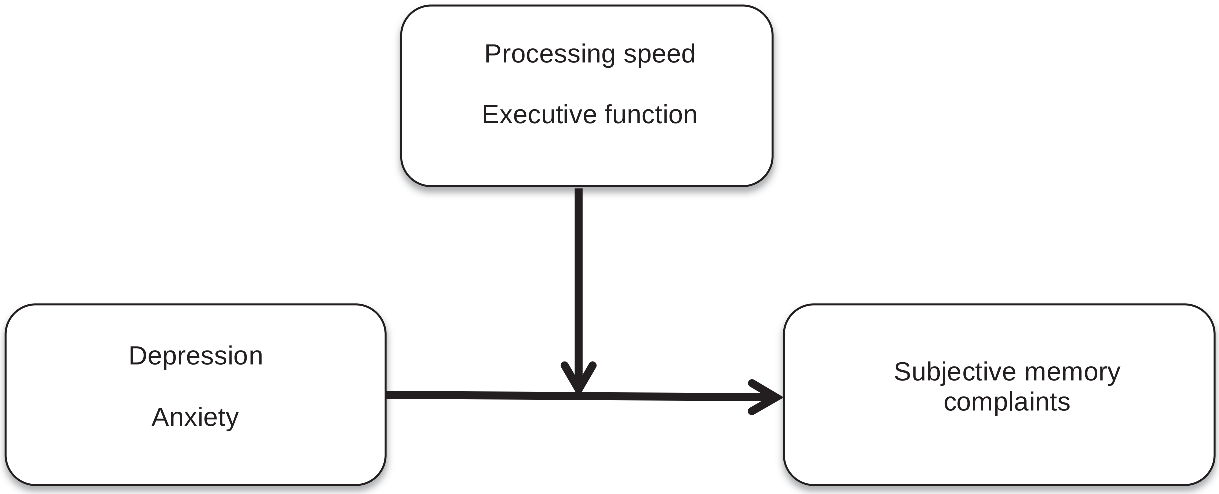

Figure 7. Proposed aetiological model of subjective memory complaints.

Method

Participants

The participant sample comprised 94 people (62.8% female) aged 40 and above, who volunteered for the study in response to community advertisements, snowball sampling through the researchers' social networks, and contact with local community groups.

Procedure

Participants first completed a survey in either online (91.5%) or hard copy format, which contained three sections: first demographic details and other covariates were assessed; second, spontaneous reports of SMCs were elicited; and third was a structured questionnaire measure of SMCs. Participants who volunteered then completed neuropsychological testing sessions between nine and eleven months later (due to availability of resources), assessing the relevant cognitive domains of processing speed, executive functioning and memory, affective symptoms of depression and anxiety, and covariates of motor speed and pre-morbid intelligence. Tests were administered in a fixed order, taking 60-75 minutes in total.

Measures

Subjective memory complaints. Participants completed a survey containing two measures of SMCs: open-ended questions eliciting participants' spontaneous reports of up to seven everyday memory difficulties and the distress associated with each of them; and a structured questionnaire that asked participants to rate the distress associated with each of 24 specific SMCs (e.g., "trouble remembering the names of people you have met", "forgetting appointments"). Both measures asked participants to rate the distress associated with each SMC on a 7-point Likert scale, where 1 represented "not at all a problem", 4 "sometimes a problem", and 7 "one of my biggest problems" (see Burmester et al., 2015, for further details), thus giving four overall measures of SMCs: the number of spontaneously reported SMCs, the distress associated with spontaneously reported SMCs, the number of questionnaire items endorsed, and the distress associated with questionnaire items.

Objective cognitive functioning. As measures of processing speed, participants completed the Symbol Search and Coding subtests from the Wechsler Adult Intelligence Scale (4th edition; WAIS-IV; Wechsler, 2008), consistent with the measures used by previous studies of SMCs (e.g., Mol et al., 2006; Wahl et al., 2010). Participants completed three measures of executive functioning; the Stroop task (Golden, 1978) assesses inhibition and selective attention, the Trail Making Test (TMT; Reitan, 1955) assesses sequencing and divided attention abilities, and the Verbal Fluency Test (Delis, Kaplan, & Kramer, 2001) assesses problem-solving, divided attention, and initiation. Participants completed the Rey Auditory Verbal Learning Test (RAVLT; Strauss, Sherman, & Spreen, 2006) as a measure of verbal/auditory memory, and the Rey Complex Figure Test (RCFT; Meyers & Meyers, 1995) for visual memory.

Depression and anxiety symptoms. Participants completed the Beck Depression Inventory (2nd edition; BDI-II; Beck, Steer, & Brown, 1996) and the State-Trait Anxiety Inventory (STAI; Spielberger, 1983).

Covariates. In the first section of the survey, participants indicated their age bracket (coded as 1 = 40-44, 2 = 45-49, 3 = 50-54, 4 = 55-59, 5 = 60-64, 6 = 65-69, 7 = 70-74, 8 = 75-79, 9 = 80-84, and 10 = 85 and above), gender, ethnicity, highest level of education (where 1 = high school attendance, 2 = school certificate, 3 = university entrance qualification, 4 = tertiary certificate or diploma, 5 = bachelor's degree, and 6 = postgraduate qualification), and number of hours worked per week (where 1 = less than 20, 2 = 20-29, 3 = 30-39, 4 = 40-49, 5 = 50-59, and 6 = 60 or more). Participants also indicated whether they had ever consulted a doctor about their memory difficulties, whether they had ever experienced neurological events (e.g., stroke, seizure), and rated their mood and stress levels over the last six months, and levels of social support, physical health, and physical exercise on a 4-point scale (where 1 = excellent, 2 = good, 3 = fair, and 4 = poor/bad).

Motor speed and premorbid intelligence were also assessed as potential confounds, and were measured respectively by the Coin Rotation Task (CRT; Mendoza, Apostolos, Humphreys, Hanna-Pladdy, & O'Bryant, 2009; Thornton, 2014) and the National Adult Reading Test (NART; Nelson & Willison, 1991).

Data Analysis

Qualitative responses to the open-ended assessment of SMCs were coded using content analysis (Krippendorf, 2013) by the primary researcher and then checked by a second rater for category consistency. Initial inter-rater agreement was 93.19%, with Cohen's kappa $\kappa = 0.93$, and after discussion of disagreements final inter-rater agreement was 100%. Further details of this procedure are provided in Burmester et al. (2015).

Quantitative data was analysed using the SPSS software package (v23). First, raw scores on measures of processing speed, executive functioning, memory, depression, anxiety, motor speed, and pre-morbid intelligence were converted to z-scores using age appropriate norms as detailed in Table 7. Individual SMCs with distress ratings of "1" were excluded from analysis as they represented SMCs which were "not at all a problem", and thus the remaining data represented memory complaints of some subjective significance (in the range 2-7). Second, multivariate analyses of variance were used to assess differences due to potential confounding variables. Then, correlations were inspected to find which variables contributed most to the aetiological model. Finally, moderation analyses were conducted using linear regression models in SPSS and an online R-based calculator (Preacher, Curran, & Bauer, 2006) for simple slopes analysis.

Table 7. Sources of Norms for Neuropsychological Measures

Measure	Norms Source
Coding	Wechsler (2008)
Symbol Search	Wechsler (2008)
Trail Making Test	Tombaugh (2004)
Stroop	Golden (1978)
Verbal Fluency	Delis, Kaplan, and Kramer (2001)
Rey Auditory Verbal Learning Test	Strauss, Sherman, and Spreen (2006)
Rey Complex Figure Test	Meyers and Meyers (1995)
Beck Depression Inventory (2nd edition)	Roelofs et al. (2013)
State-Trait Anxiety Inventory	Ages 40-69: Spielberger (1983) Ages 70+, State subscale: Potvin et al. (2011) Ages 70+, Trait subscale: Bergua et al. (2012)
Coin Rotation Task	Thornton (2014)
National Adult Reading Test	Barker-Collo, Thomas, Riddick, and de Jager (2011)

Results

Descriptive Statistics

Participants were generally well-educated, with 26.6% having a postgraduate qualification, 22.3% having a bachelor’s degree, 26.6% having a tertiary diploma or certificate (not a degree), 9.6% each having full or partial high school qualifications, and 5.3% having high school attendance with no qualification. The median age of participants was in the 65-69 bracket, with 10.6% aged 40-44, 6.4% aged 45-49, 12.8% aged 50-54, 6.4% aged 55-59, 6.4% aged 60-64, 10.6% aged 65-69, 20.2% aged 70-74, 11.7% aged 75-79, 11.7% aged 80-84, and 3.2% aged 85 or older. The majority of participants indicated New Zealand European ethnicity (85.1%), with 3.2% Māori, 1.1% Asian, and 9.6% other ethnicities. The largest proportion of participants worked fewer than 20 hours per week (41.5%), with 6.4% working 20-29 hours per week, 13.8% 30-39 hours, 12.8% 40-49 hours, 5.3% 50-59 hours, and 1.1% 60 hours or more. Seventeen percent of the participants indicated that this question was not applicable to them.

Five participants (5.3%) indicated that they had seen a doctor about their memory difficulties. None of the participants reported having a history of traumatic brain injury, seizure, brain tumour, or other neurological conditions. Six people (6.4%) reported a diagnosis of epilepsy, and three (3.2%) reported a history of stroke. Twelve (12.8%) reported other neurological history, and overall, 78.7% reported no neurological history whatsoever.

Descriptive statistics for the participants’ scores on all cognitive and psychological variables are shown in Table 8.

Univariate Results

Independent samples t-tests, one-way analyses of variance and Spearman’s rank-order correlations were used to analyse the effect of demographic and other participant variables on SMC measures.

Independent samples t-tests showed that the only significant effects of gender were that females (*M* = 3.28, *SD* = 1.43) spontaneously reported more SMCs than males (*M* = 2.39, *SD* = 1.56; *t*(85) = -2.70, *p* = .008, *d* = .601) and females (*M* = 3.31, *SD* = .61) rated the questionnaire items they endorsed as significantly more distressing (*t*(92) = -2.00, *p* = .049, *d* = .413) than males did (*M* = 3.03, *SD* = .74).

One-way analyses of variance showed that there were no significant effects of age or ethnicity on any of the SMC variables, nor were there significant differences in SMCs between participants who had seen a doctor regarding their memory and those who had not, or between those who reported neurological history of any kind and those with none.

Spearman's rank-order correlations showed that neither education nor number of hours worked per week was significantly related to any of the SMC variables.

Table 8. Test Score Descriptive Statistics (*z*-scores for sample)

Construct	Measure	*n*	Minimum	Maximum	Mean	Standard deviation
SMCs	Number of spontaneously reported SMCs	87	1	7	2.94	1.54
	Distress associated with spontaneously reported SMCs	87	2	6	3.65	.94
	Number of SMC questionnaire items endorsed	94	2	24	14.41	6.16
	Distress associated with endorsed SMC questionnaire items	94	2	5	3.20	.67
Processing speed	Coding	94	-1.67	3.00	.76	.90
	Symbol Search	94	-2.00	3.00	.68	.97
Executive functioning	Stroop (word reading)	94	-2.45	2.70	.02	.91
	Stroop (colour naming)	94	-2.47	2.67	-.28	1.00
	Stroop (interference trial)	94	-2.50	2.50	.29	.94
	TMT – Part A	94	-3.91	2.71	.13	1.09
	TMT – Part B	94	-4.28	3.42	.13	1.50

Construct	Measure	*n*	Minimum	Maximum	Mean	Standard deviation
	Verbal fluency (letters)	94	-1.33	3.00	1.04	1.21
	Verbal fluency (categories)	94	-1.33	3.00	1.21	1.22
	Verbal fluency (switching)	94	-3.00	3.00	.66	1.14
Memory	RAVLT Trials 1-5	94	-1.76	3.70	.75	1.20
	RAVLT Trial B	94	-3.00	3.75	.65	1.31
	RAVLT Trial 6	94	-3.76	3.44	.51	1.37
	RAVLT Trial 7	94	-3.48	2.71	.43	1.25
	RCFT immediate recall	93	-3.28	3.64	.62	1.23
	RCFT delayed recall	93	-3.89	4.36	.60	1.34
Depressive Symptoms	BDI – II	92	-1.78	1.14	-.22	.73
Anxiety symptoms	STAI – State	93	-1.51	2.17	-.28	.87
	STAI – Trait	93	-1.51	2.36	-.37	.87
Other covariates	Mood	93	1	4	1.91	.64
	Stress	94	1	4	2.19	.69
	Social support	92	1	3	1.75	.67
	Physical health	93	1	4	1.82	.66
	Exercise	93	1	4	2.19	.81
	Motor speed – dominant hand	92	-2.88	4.13	.51	1.29
	Motor speed – non-dominant hand	92	-3.55	4.14	.08	1.23
	Premorbid intelligence	94	-.58	2.89	1.56	.69

Note. SMC = subjective memory complaint.

Correlations between the subjective memory, cognitive, and psychological variables are shown in Table 9. Only depressive symptoms were consistently associated with all SMC measures. Of the SMC measures, the number of questionnaire items endorsed was most frequently associated with cognitive measures, being significantly correlated with scores on the Coding, Symbol Search, and Stroop interference trial measures. Other significant correlations showed that RAVLT B scores were positively related to the number of spontaneously reported SMCs, and that greater distress associated with questionnaire items was related to poorer social support and lower premorbid intelligence.

Table 9. Test Score Correlations

Construct	Measure	Number of spontaneously reported SMCs	Distress associated with spontaneously reported SMCs	Number of SMC questionnaire items endorsed	Distress associated with endorsed SMC questionnaire items
Processing speed	Coding	-.03	-.01	-.21*	-.15
	Symbol Search	-.02	-.03	-.25*	-.17
Executive function	Stroop (word reading)	-.01	.00	-.12	.01
	Stroop (colour naming)	.11	.12	-.11	.10
	Stroop (interference trial)	-.03	.01	-.23*	-.15
	TMT – A	.07	.03	.04	-.10
	TMT – B	-.01	.04	.00	-.17
	Verbal fluency (letters)	.16	-.01	-.10	-.04
	Verbal fluency (categories)	.13	.18	-.11	-.10
	Verbal fluency (switching)	-.03	-.02	-.18	-.17
Memory	RAVLT Trials 1-5	.20	.14	-.08	.01
	RAVLT Trial B	.27**	.14	.02	.10
	RAVLT Trial 6	-.06	.02	-.17	-.15
	RAVLT Trial 7	.02	.02	-.15	-.07

Construct	Measure	Number of spontaneously reported SMCs	Distress associated with spontaneously reported SMCs	Number of SMC questionnaire items endorsed	Distress associated with endorsed SMC questionnaire items
	RCFT immediate recall	-.14	-.03	-.06	-.19
	RCFT delayed recall	-.08	-.05	.00	-.12
Depressive Symptoms	BDI – II	.22*	.30**	.34**	.27**
Anxiety symptoms	STAI – State	-.07	.02	.11	-.04
	STAI – Trait	.12	.17	.13	.10
Other covariates	Mood	.09	.20	.01	.17
	Stress	.04	.06	.00	.13
	Social support	-.05	.07	.06	.21*
	Physical health	.09	.13	.04	.04
	Exercise	-.07	.05	.00	.02
	Motor speed – dominant hand	-.03	-.04	-.10	.04
	Motor speed – non-dominant hand	-.06	.03	-.10	.00
	Premorbid intelligence	-.02	-.21	-.11	-.22*

* = $p < .05$.
** = $p < .01$.
Note. SMC = subjective memory complaint; TMT = Trail Making Test; RAVLT = Rey Auditory Verbal Learning Test; RCFT = Rey Complex Figure Test; STAI = State-Trait Anxiety Inventory.

Multivariate Results

A moderation analysis was conducted using multiple regression. First, an index of processing speed was calculated using the procedure for combining Coding and Symbol Search scores given in Wechsler (2008) in order to prevent substantial collinearity. Then, scores on the three predictor variables (processing speed index, Stroop interference trial, and BDI-II) were centred and two interaction terms (between the centred processing speed index and Stroop interference trial scores and centred depressive symptoms) were created.

The following assumptions of multiple regression were met (using criteria from Tabachnick & Fidell, 2013). The ratio of cases to independent variables exceeded the recommended $N \geq 50 + 8m$, with $N = 94$ participants and $m = 5$ predictor variables. The dependent variable did not demonstrate significant skewness ($p = .183$) but did have a significantly platykurtic distribution ($p = .014$) and so the distribution of regression residuals was also analysed. Residuals were approximately normally distributed, with non-significant skewness ($p = .132$) and kurtosis ($p = .064$). Inspection of bivariate scatterplots showed no evidence of non-linearity. There were no univariate outliers ($z \geq \pm 3$SD) for any of the dependent or predictor variables. A regression analysis using the three non-interaction term predictors (i.e., processing speed, Stroop interference trial score, and depressive symptoms) showed no multivariate outliers (Mahalanobis distances exceeding $\chi^2(3) = 16.27$, $p < .001$).

The three predictor variables and two interaction terms were entered into a regression with the number of questionnaire items endorsed as the dependent variable (as this was the only SMC measure that correlated significantly with processing speed and executive function measures). The overall model was significant ($R^2 = .207$, $F(5, 86) = 4.497$, $p = .001$, $f^2 = .261$). As shown in Figure 8, there was a significant main effect of depressive symptoms on the number of SMC questionnaire items endorsed ($\beta = .31$, $t = 3.11$, $p = .003$), whereby more depressive symptoms were associated with more SMCs. There was also a significant effect of the interaction between processing speed and depressive symptoms ($\beta = -.31$, $t = -2.20$, $p = .030$), showing that the inverse relationship between processing speed and subjective memory complaints was greater at higher levels of depressive symptoms. Main effects of processing speed, Stroop interference trial score, and the interaction between Stroop interference trial score and depressive symptoms were all non-significant (p = .264, .508, and .081 respectively).

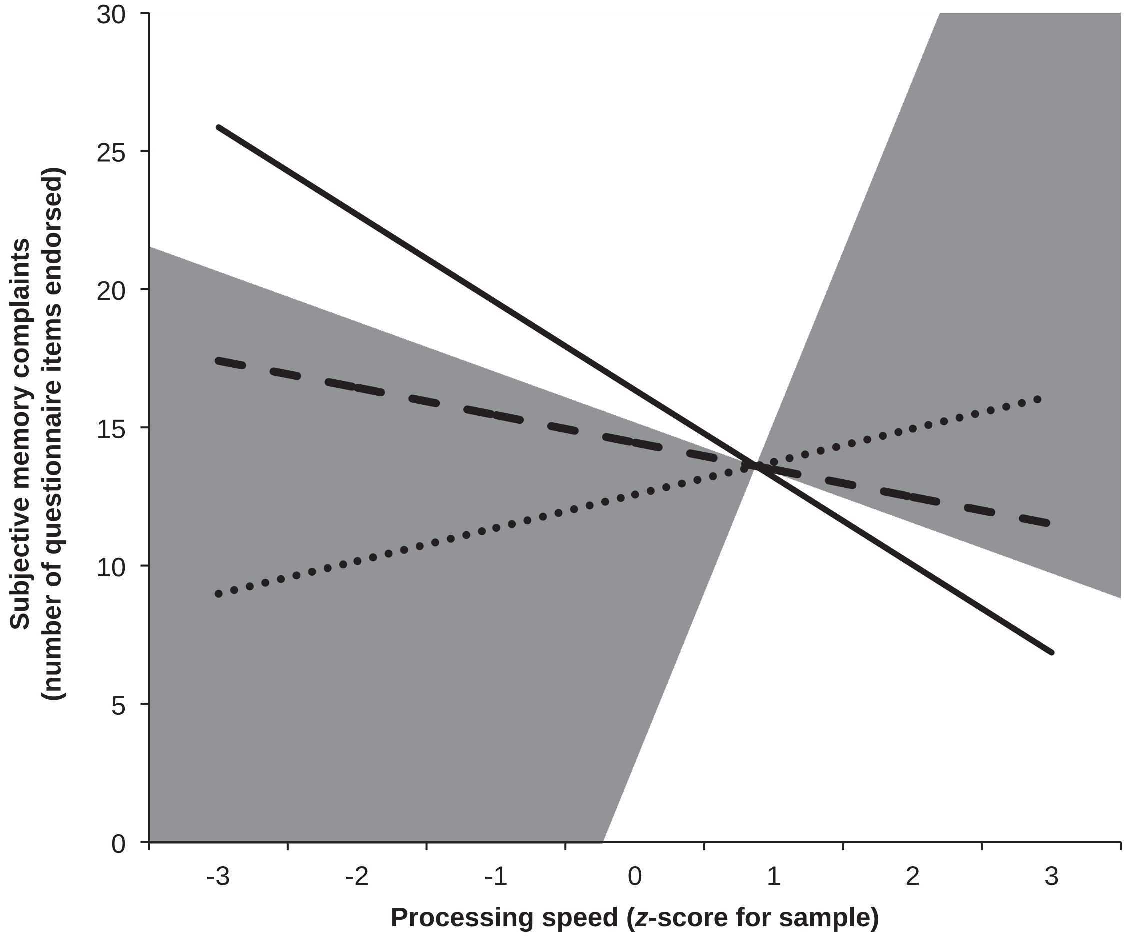

Figure 8. Moderation of the effect of processing speed on subjective memory complaints by depressive symptoms.
Note. Shaded areas denote regions of non-significance. The dotted line shows the relationship between processing speed and subjective memory complaints for participants with low (< *M*-1*SD*) depressive symptoms; the dashed line for participants with moderate (> *M*-1*SD* and < *M*+1*SD*) depressive symptoms; the solid line for participants with high (> *M*+1*SD*) depressive symptoms.

Discussion

Previous studies investigating the aetiology of SMCs have produced mixed evidence for the role of actual memory functioning and suggest that various other cognitive, psychological and measurement variables are implicated. However, few studies have examined the roles of these variables simultaneously. The current study tested an aetiological model based on previous findings regarding SMCs and theories of cognitive ageing.

Specifically, the model proposed that anxiety and depressive symptoms were related to SMCs, and that processing speed and executive functioning moderated this relationship. This hypothesis was partially supported by the results of a moderated regression analysis, which showed that the number of SMCs endorsed on a questionnaire was significantly predicted by depressive symptoms and an interaction between depressive symptoms and processing speed. Greater depressive symptoms were associated with more SMCs overall and for participants with relatively high levels of depressive symptoms, SMCs were inversely related to processing speed.

The main effect of depressive symptoms is consistent with a majority of evidence regarding depressive aetiology of SMCs (Benito-León et al., 2010; Hülür et al., 2014; Rickenbach et al., 2015). Here, correlations between depressive symptoms and SMCs were robust to different methods of SMC assessment, further attesting to the strength of this effect and suggesting depressive symptoms are more resistant to methodological differences than other variables (which may explain the relative consistency of findings linking them to SMCs). For example, cognitive variables were only related to selected (and often single) measures of SMCs.

Results were somewhat consistent with theories of cognitive ageing which emphasise the key role of processing speed in underpinning all age-related declines in cognitive functioning. However, they also suggest that processing speed may only be relevant to subjective perceptions of cognitive functioning in the context of relatively high rates of depressive symptoms. It is noted that this finding contradicts an earlier assertion that SMCs might better reflect cognitive functioning in the *absence* of depressive symptoms (Zeintl, Kliegel, Rast, & Zimprich, 2006). One explanation for the current findings is that processing speed decline underlies objective memory difficulties, but this pattern only becomes subjectively evident (and triggers SMCs) when there is sufficient attention to memory problems – as when depressive symptoms are high. This explanation is supported by evidence that SMCs are also predicted by self-focused attention (Chin et al., 2014) and negative rumination about one's performance (Jorm et al., 2004). Another possibility is that depressive symptoms cause a slowing in processing speed, and this effect is more manageable at lower levels of depressive symptoms, but less so when depressive symptoms are sufficiently high (thus manifesting as SMCs). Further work investigating the influence of these variables is necessary in order to distinguish the possible explanations.

Broadly, executive functioning abilities were not significant predictors of SMCs, although the number of questionnaire items endorsed was correlated with scores on the Stroop interference trial (an indication of selective attention, which is just one aspect of executive function). This factor was no longer significant in the regression model, which may suggest that any predictive value it could offer was subsumed by that of processing speed instead. This interpretation is consistent with similar findings where processing speed predicts objective memory performance (Mol et al., 2006; Wahl et al., 2010) and functional abilities (Lin et al., 2013), as well as Salthouse's (1996) assertion that processing speed explains the majority of age-related variance in other cognitive variables. Alternatively, executive functioning may have a smaller role in explaining SMCs but this was not significant here due to the limited statistical power provided by the sample size.

Evidence for the proposed aetiological model was only observed for one type of SMC measure (i.e., only the number of SMC questionnaire items was related to processing speed and depressive symptoms). This finding adds weight to previous suggestions that assessment methods may underlie some of the variability in findings to date, particularly when considered in contrast to the observation that a memory measure (RAVLT B) was only correlated with a *different* measure of SMCs (the number reported spontaneously). Previous work has highlighted various limitations of a number of SMC assessment methods (Rabin et al., 2015), including the potential for a 'catch 22' situation whereby participants forget to report their memory difficulties when required to generate such reports themselves (Apolinario et al., 2012). Open-ended assessments require free recall of memory difficulties, which relies on intact functioning of the very processes in question. Such an interpretation is consistent with the positive correlation observed here between RAVLT B scores and spontaneously reported SMCs, whereby participants with better memory performance had more SMCs. By contrast, questionnaire-format assessments instead provide cues for the recall of specific types of difficulties and may elicit more thorough reports of subjective memory that are less vulnerable to omissions that result from memory failures. Consequently, the observed support for processing speed and depressive symptoms as factors underlying SMCs may only be evident when this ‘catch 22’ confound is minimised.

Previous work has shown that questionnaire assessments indeed produce SMC reports that contain a larger number of SMCs than open-ended questioning of the same participants (Burmester et al., 2015), and that open-ended (but not questionnaire) methods of SMC assessment relate to actual memory performance (Mattos et al., 2003). However, it is also possible that questionnaire reports elicit over-reporting of SMCs, including memory difficulties which cause little distress or functional impairment.

Overall, few significant relationships between SMCs and other variables were observed, suggesting that SMCs are a poor general indicator of cognitive functioning (including memory performance) and implying that they hold little clinical value unless quantified as the number of memory difficulties an individual endorses when asked specifically about a range of given difficulties. Also contrary to expectations, SMCs failed to exhibit significant relationships with anxiety. This may indicate the lack of influence of anxiety on SMCs, or may reflect findings specific to the anxiety measure used, or other limitations of the study. Further, SMCs rarely showed relationships with demographic or other participant variables, which may also suggest a legitimate absence of these links in the population, or result from limitations of this study.

Implications

Results of the current study are particularly relevant to clinical settings, given that the volunteer sample represents the same population that would be presumed to self-refer themselves to health professionals regarding memory difficulties. In practice, the findings suggest that when consulting with a person with SMCs, mood symptoms are the most important additional factor to investigate. If individuals have depressive symptoms above the mean for their age (even if these are sub-clinical), then it may also be helpful to assess cognitive functioning in more depth – particularly processing speed. Similarly, interventions for these variables are likely to have the greatest impact. Clinicians are advised to recognise the importance of SMCs even in middle-aged adults, and to be aware of the implications that different methods of SMC assessment can have on their findings. Questioning about specific examples of memory difficulties is advised (consistent with recent recommendations from Rabin et al., 2015), in order to avoid the confound of individuals forgetting to report any difficulties.

Limitations

The findings of this study are subject to a number of limitations, the most notable of which relate to characteristics of the sample. The overall sample size was adequate for the analyses used, but still small by absolute standards and thus some relationships may not have been observed due to low statistical power. Valid subgroup analyses could also not be performed. Secondly, the sample consisted of volunteers, who can differ from the general population in important ways such as education and level of memory-related concern (Reid & MacLullich, 2006). Indeed this sample was relatively highly educated. However, this aspect is perhaps less concerning as a volunteer sample means that the findings relate specifically to the very people for which SMCs are problematic, and thus have greater clinical importance. Thirdly, the sample used in this study spanned a relatively large age range, incorporating both middle-aged and older adults, and so may be vulnerable to confounding of different age-related effects. While much previous research on SMCs has focused on older adults only, it was however deemed important to include middle-aged participants here as well, because they have also demonstrated increasing rates of SMCs (Ponds et al., 2000), and are relatively under-studied in this respect. Results of the current study also showed no significant differences in SMCs on the basis of age, suggesting that SMCs are similarly common and as distressing for middle-aged adults as they are for older adults. Middle-aged participants are also more likely to still be engaged in high-level employment, and as such there may be functional implications of memory difficulties that are less likely to occur in older adults who are retired, engaged in voluntary employment, or working fewer hours (Rijs, Comijs, van den Kommer, & Deeg, 2013).

Other methodological limitations include the potential for spurious findings given the large number of variables examined. For example, other relationships were observed (e.g., women spontaneously reported more SMCs than men, the number of spontaneously reported SMCs was positively associated with scores on Trial B of the RAVLT, and greater distress ratings for SMCs endorsed on the questionnaire were related to lower levels of both social support and premorbid intelligence) and consequently further research is needed in order to verify the findings observed here in other samples.

There was a substantial delay between survey administration and neuropsychological testing sessions (nine to eleven months), which may have confounded findings. However, such a delay is likely to lead to more conservative estimates of the relationships between variables than if the two assessments had occurred closer together, and consequently the relationships which were observed here can be assumed to be relatively robust to this limitation. The exclusion of all SMCs which participants rated as “not at all a problem” (both spontaneously reported and as questionnaire items) also means that findings are relevant only in the context of functionally or emotionally salient memory difficulties, and not for those which participants consider to have little impact on their lives. Finally, the cross-sectional nature of the research limits the analyses to associations between variables rather than those that would allow causal conclusions. Ideally, SMC measures would have been taken during the neuropsychological testing sessions (in addition to the earlier survey), however practical constraints and the unforeseen delay between data collection phases meant that this was unfortunately not possible.

Future Research

This study offers a number of promising directions for future research into the aetiology of SMCs. Firstly, it suggests that the interaction of cognitive and affective variables can be helpful in explaining SMCs, and research of this nature in larger samples is warranted. In particular, further investigations of SMCs and their correlates for participants with different levels of depressive symptoms would be useful in verifying and investigating the relationships observed here. Also helpful would be studies that can distinguish between the various explanations for the current findings – for example, incorporating measures of rumination and/or self-focused attention to test the hypothesis that these symptoms of depression increase the subjective salience of the effects of declines in processing speed.

Other fruitful avenues for exploration relate to the measures of SMCs. Future research is advised to make use of specific examples of memory difficulties when assessing SMCs, and validation of these types of questionnaires is necessary. Refinement of the exact items/examples which offer greatest predictive value is also needed, as is direct investigation of the ‘catch 22’ nature of SMCs outlined earlier – verifying whether open-ended SMC assessment does reflect failures of free recall, and exploring how well this can be rectified by the use of specific questionnaire assessments.

Other research areas raised by the current research include investigation of the effect on SMCs of interventions for depressive symptoms and processing speed, further investigation of the impact and characteristics of SMCs for middle-aged participants, and whether the kinds of cognitive difficulties that participants may label as ‘memory’ problems in fact reflect memory functioning or other cognitive abilities.

Conclusion

This study investigated the interaction of cognitive and psychological variables in explaining SMCs, and showed that while depressive symptoms were the strongest predictor of SMCs overall, processing speed was also inversely related to SMCs for participants with relatively high levels of depressive symptoms. Furthermore, this relationship was only observed when SMCs were operationalised as the number of memory difficulty items endorsed on a questionnaire. These findings are supported by previous findings regarding the role of depressive symptoms in explaining SMCs, and offer potential explanations for why other results regarding the aetiology of SMCs to date have been mixed. Further research in larger samples is warranted.

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CHAPTER 8

GENERAL DISCUSSION

Overview

The initial aim of this research was to test an aetiological model of SMCs that incorporated both cognitive and affective factors. In order to address this aim, literature on the topic was first reviewed (Chapters 1-3). Following the literature review, further aims were identified: namely, to determine how SMCs differ as a function of the methods used to assess them, and to assess the degree to which different methods of assessing SMCs underlie the variability in their relationship with objective memory performance. These aims were respectively addressed in Chapters 5 and 6. The proposed aetiological model was also broadened to include additional factors, and was examined in Chapter 7.

The current chapter begins by revisiting and addressing each of the research questions and hypotheses in turn. Next, overall limitations of the research are discussed and suggestions made for future research. The chapter concludes with a summary of the research's contribution to the literature and some personal reflections on the project.

Research Questions

1. To what extent do reported SMCs reflect the method with which they are assessed? Based on a suggestion from Apolinario et al. (2012), it was hypothesised that a 'cueing effect' would be evident on questionnaire-prompted SMCs but not spontaneously reported SMCs.

Chapter 5 examined this question. A survey was used to assess SMCs, containing open-ended questions asking participants to describe (and rate the distress associated with) memory difficulties they experienced in daily life, as well as rate the distress associated with a set of 24 prescribed memory difficulties. Overall, participants reported fewer SMCs spontaneously than they endorsed on the questionnaire, but tended to rate the former as more distressing. Results also showed a number of differences in the reporting of SMCs through each method. There were a number of SMCs garnered through open-ended questioning which were not featured in the questionnaire (e.g., "remembering multiple things at once"), consistent with the hypothesised cueing effect whereby questionnaires may miss assessment of some SMCs not contained within their items. The converse was also true, whereby some SMCs assessed in the questionnaire were not mentioned in response to the open-ended questions (e.g., “not recognising places you have been to before”). Spontaneous reports of SMCs demonstrated high ecological validity, although this was countered by the greater robustness of questionnaire assessments to a ‘catch 22’ situation whereby some endorsed SMCs were not reported spontaneously (perhaps due to memory failures in themselves).

2. How do assessment method-based differences in SMCs explain their relationship with objective memory performance? It was hypothesised that SMCs gathered in response to a questionnaire would be less strongly related to objective memory performance than those gathered via open-ended questions, given previous results to this effect from Mattos et al. (2003).

This question was addressed in Chapter 6. The hypothesis was not supported, with results showing that neither method produced reports of SMCs that were significantly convergent with objective measures.

3. To what extent do SMCs reflect cognitive, psychological and demographic factors? It was hypothesised that SMCs would be most strongly related to depressive symptoms, less so to anxiety, and that the relationship between affective symptoms (anxiety and depression) and SMCs would be moderated by processing speed and/or executive functioning abilities. It was also hypothesised that a stronger relationship between cognition and SMCs would be found for individuals with more depressive symptoms than those with minimal depressive symptoms.

Results in Chapter 7 partially supported these hypotheses, showing that depressive symptoms were positively related to SMCs (assessed with a questionnaire), and more strongly so than any other psychological or cognitive factor. Anxiety was not significantly related to SMCs. The effect of depressive symptoms on SMCs was moderated by processing speed (with processing speed only being significantly predictive of SMCs for participants with relatively high levels of depressive symptoms). One measure of executive functioning, the ability to inhibit interference, was related to SMCs at a univariate level however this disappeared when the influence of depressive symptoms and processing speed were taken into account.

Strengths and Limitations

Survey

The survey was methodologically strong in that it used different methods to assess SMCs, was completed by a large number of participants, and assessed a wide range of demographic confounds. Attempts were also made to increase the accessibility of the survey by engaging participants who may not have had Internet access to complete a hard copy of the survey instead, and engaging directly with community groups who represented older adults.

Nevertheless, a number of limitations may have also affected the validity of the survey results. No matter the administration and recruitment methods, people who were unengaged in the community are unlikely to have been aware of the opportunity to participate, and thus the sample likely represents a particular subgroup of the community who already participate in external activities and are interested in their cognitive functioning.

Limitations that apply to all survey methods of research are also relevant to this study, including those that relate to the particular wording of questions (e.g., “How much of a problem is [this memory difficulty] for you in everyday life?”) and the response options provided (e.g., the scale of 1-7 used to rate the distress associated with SMCs). Appendix N provides a discussion of the differences in findings depending on whether ratings of ‘1’ were included or excluded in the data.

A special point to note is the use of “memory” difficulty in the survey as opposed to “cognitive” difficulty, which may have limited some responses to those only related to memory. However, as described in Chapter 4, this choice was made in the interests of making the survey more accessible for laypeople, reflecting the documented worry about "memory" difficulties, and with the view that the problems reported were likely to relate to other cognitive abilities as well as memory. Evidence supporting this view is that participants still spontaneously reported SMCs in Chapter 5, which might be considered as reflective of non-memory cognitive abilities. For example, the spontaneously reported SMC category of "remembering multiple things at once" might be considered analogous to the category of "multi-tasking", which was identified in previous questionnaires but not included in the current one as it ostensibly related to non-memory cognitive abilities.

Neuropsychological Testing

This aspect of the research was conducted in a professional setting, by trained administrators, with robust measures and a within-subjects design. Results are highly reliable due to the inter-rater procedures used to check and correct errors in scoring methods. However, errors in administration are possible and difficult to identify post-hoc.

A primary limitation of the neuropsychological testing results is that they occurred nine to eleven months after the survey, and thus the two types of data collection were not strictly cross-sectional. This is acknowledged and discussed in Chapter 7. A similarly large limitation is the relatively small sample size of the participants who completed testing (N = 94). Although this sample was statistically adequate for the analyses presented, and was the maximum number of participants who could complete a testing session, results would nevertheless be more robust if the study was completed on a larger scale. This would also allow more detailed analyses (e.g., subgroups) to be conducted.

Other limitations include the nature of the sample – similar to those who participated in the survey, neuropsychological testing participants are likely to have been motivated by interest in, or concern about, their own cognitive functioning and so represent a subgroup defined as such. This may explain some aspects of the results – for example, some evidence has suggested that links between SMCs and depressive symptoms are stronger in volunteer samples than the general population (Benito-Leon et al., 2010; Rouch et al., 2008), and in women (who made up the majority of this sample; Tomita et al., 2014). Similarly, the sample tended to be more highly educated than would be expected for the general population (26.6% of the sample had a postgraduate qualification). This difference may suggest that the participants were more likely to have above average cognitive functioning, and/or less likely to experience memory decline due to the higher cognitive reserve provided by their education (see Christensen, Anstey, Leach, & Mackinnon, 2008). However, use of the NART was included in order to control for education levels, and indeed scores on this test did not correlate significantly with any measures of SMCs. Additionally, the educated nature of the participants likely also reflects the participants' relatively greater attention to their cognitive performance and engagement with cognitive improvement strategies.

Contribution to the Literature

Although a large number of studies have examined SMCs and their links with cognitive and psychological variables, this research offers unique strengths in its examination of these links. To the author's knowledge, this study is the first to assess the relationship between SMCs and objective cognitive functioning using multiple methods of SMC assessment in a within subjects design for both middle-aged and older adults. Results offer important insights into the interaction of cognitive and psychological factors in explaining SMCs, and in particular highlight the context in which processing speed contributes to SMCs, which was previously not clearly delineated.

Personal Reflections

Conducting this research has been a humbling and immensely rewarding experience for me. It has highlighted the daily relevance of memory difficulties for many people and reinforced to me that they are important to address. Many participants who completed neuropsychological testing explained that they knew memory difficulties were common with increasing age, and although many were not overtly worried about diseases such as dementia, they nevertheless were searching for ways to mitigate their difficulties. The individual feedback and result interpretations (see Appendix M for an example) we provided were without exception welcomed by the participants, and many remarked that it had alleviated their distress just by being able to make sense of their different cognitive strengths and weaknesses. Their responses reinforced to me that while the study of disease and impairment is undoubtedly a key contribution of psychology to society, it is also important not to ignore the experiences of the vast majority of people who do not have clinical levels of impairment. I was personally inspired by how participants continually strived to improve their ability to contribute to the world, even when facing common but nevertheless distressing challenges.

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APPENDICES

Appendix A. Statements of contribution

DRC 16

MASSEY UNIVERSITY
GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION TO DOCTORAL THESIS CONTAINING PUBLICATIONS

(To appear at the end of each thesis chapter/section/appendix submitted as an article/paper or collected as an appendix at the end of the thesis)

We, the candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of Candidate: Bridget Burmester

Name/Title of Principal Supervisor: Prof. Janet M. Leathem

Name of Published Research Output and full reference: Burmester, B., Leathem, J., & Merrick, P. (2016). Subjective cognitive complaints and objective cognitive function in aging: A systematic review and meta-analysis of recent cross-sectional findings. *Neuropsychology Review*, 26(4), 376-393. doi: 10.1007/s11065-016-9332-2

In which Chapter is the Published Work: 1.

Please indicate either:

- The percentage of the Published Work that was contributed by the candidate: 85%

  and / or

- ~~Describe the contribution that the candidate has made to the Published Work:~~

B. Burmester
Candidate's Signature

23/01/2017
Date

Principal Supervisor's signature

24.1.17
Date

GRS Version 3– 16 September 2011

DRC 16

MASSEY UNIVERSITY
GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION TO DOCTORAL THESIS CONTAINING PUBLICATIONS

(To appear at the end of each thesis chapter/section/appendix submitted as an article/paper or collected as an appendix at the end of the thesis)

We, the candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of Candidate: Bridget Burmester

Name/Title of Principal Supervisor: Prof. Janet M. Leathem.

Name of Published Research Output and full reference:

Burmester, B., Leathem, J., & Merrick, P. (2015). Assessing subjective memory complaints: A comparison of spontaneous reports and structured questionnaire methods. *International Psychogeriatrics*, 27(1), 61-77. doi: 10.1017/S1041610214001161

In which Chapter is the Published Work: 5.

Please indicate either:

- The percentage of the Published Work that was contributed by the candidate: 80%

~~and / or~~

- ~~Describe the contribution that the candidate has made to the Published Work:~~

B. Bur

Candidate's Signature

23/01/2017.

Date

Principal Supervisor's signature

24.1.2017

Date

GRS Version 3– 16 September 2011

Appendix B. Ethical approval

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

5 June 2013

Bridget Burmester
13 Kainui Road
Hataitai
WELLINGTON 6021

Dear Bridget

Re: HEC: Southern A Application – 13/26
Understanding the relationship between self-reported memory difficulties and objective memory performance in middle-aged and older adults

Thank you for your letter dated 30 May 2013.

On behalf of the Massey University Human Ethics Committee: Southern A I am pleased to advise you that the ethics of your application are now approved. Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

B J Finch.

Dr Brian Finch, Chair
Massey University Human Ethics Committee: Southern A

cc Prof Janet Leathem
School of Psychology
WELLINGTON

A/Prof Paul Merrick
School of Psychology
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Appendix C. Survey advertisement

Appendix D. Initial recruitment email

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

22 October 2013

Everyday Memory Difficulties – Summary of Results

Dear <<Participant>>,

In June or July this year you completed a survey about memory difficulties, which was part of a research project being conducted at Massey University by Bridget Burmester (primary researcher) and Professor Janet Leathem (primary supervisor). Over 400 people aged 40 or above completed the survey, which provided a large and rich amount of data. Thank you for your contribution by taking part!

We are writing now because you opted to receive a summary of the results of the survey.

As you may recall, the aim of the survey was to answer two questions: namely, what memory difficulties do people report, and do these reports differ depending on the way in which people are asked about their memory difficulties?

Regarding the kinds of memory difficulties people reported, *forgetting other people's names* was three times more common than any other difficulty. However, forgetting people's names was not rated as the biggest problem. *Having to remember multiple things at once*, *not recognizing people's faces*, and *forgetting what you have told someone* worried people more.

In order to find out whether reports of memory difficulties differed depending on the *way* people were asked about their memory difficulties, the responses on the questionnaire were compared to responses people made open-ended questions. We found that the questionnaire sometimes missed the memory difficulties that concerned people most (such as remembering multiple things at once). Previous research which suggested that there might be a "catch 22", where some people forget to report the things they forget was not borne out. While this might happen in some cases, our findings suggested that it did not affect the results in any meaningful way.

The results overall are important because they give new insights into the best ways to assess memory difficulties, and how people with memory difficulties might best be helped to overcome them.

The next step in the research is to find out more about everyday memory ability by inviting some participants to complete one-on-one memory testing with the researcher, Bridget Burmester. If you indicated on the survey that you were willing to participate in this stage of the research, you may be contacted in the next few weeks to discuss this further. Please be assured that your participation in this next stage of the research is completely voluntary.

If you have any questions about this research or would like to discuss anything further, please ring 0800 MEMORY (0800 636679), leave a message with your contact details, and we will call you back. Alternatively, you can contact either the researcher or the supervisor via the details given below.

Many thanks,

Bridget Burmester.

Contact information:

Researcher	**Supervisor**
Bridget Burmester School of Psychology Wellington Campus Massey University New Zealand	Dr. Janet Leathem School of Psychology Wellington Campus Massey University New Zealand
0800 MEMORY (0800 636679)	+64 4 801-5799 ext 62035
Email: bridgetburmester@gmail.com	J.M.Leathem@massey.ac.nz

Appendix E. Secondary recruitment emails

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

13 February 2014

Dear <<Participant>>,

In June or July 2013 you completed a survey about memory difficulties, which was part of a research project being conducted at Massey University by Bridget Burmester (primary researcher) and Professor Janet Leathem (primary supervisor).

In this survey you indicated that you could be contacted about potential participation in a second stage of the research. In this second stage we are aiming to find out more about everyday memory abilities, and we are now looking for participants. Participation in this stage would involve one-on-one memory testing with a member of the research team. Testing is expected to take approximately 60 minutes, and all participants will be reimbursed for their time and travel expenses with a $20 petrol or grocery voucher. Participation in this stage of the research is completely voluntary, even if you initially indicated your interest.

If you would like to find out more or you are interested in participating in this stage of the research, please reply to this email, or contact me on 0800 MEMORY (0800 636679).

Many thanks,

Bridget Burmester.

Contact information:

Researcher

Bridget Burmester
School of Psychology
Wellington Campus
Massey University
New Zealand

0800 MEMORY (0800 636679)

bridgetburmester@gmail.com

Supervisor

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J.M.Leathem@massey.ac.nz

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Monday 24 February 2014

Dear <<Participant>>,

Thank you for your reply to my earlier email regarding participation in my research about memory difficulties. Thank you also for your willingness to be involved or to hear more. This email is just to let you know that I will be in contact with you over the next couple of weeks as I work my way through the replies I have received. I will contact you on the phone number that you originally listed on the survey from last year. If your phone number has changed since then, just let me know by replying to this email.

I look forward to speaking with you soon.

Warm regards,

B. Burm

Bridget Burmester.

Appendix F. Survey

Section A - Participant Demographics

1. How old are you?

◯ less than 40 years
◯ 40 - 44 years
◯ 45 - 49 years
◯ 50 - 54 years
◯ 55 - 59 years
◯ 60 - 64 years
◯ 65 - 69 years
◯ 70 - 74 years
◯ 75 - 79 years
◯ 80 - 84 years
◯ 85 years or older

2. Which town or city do you live in?

____

3. Which ethnic group do you belong to? (If your answer includes more than one ethnic group, please indicate which one you consider to be your primary ethnicity).

◯ New Zealand European/ Pakeha
◯ New Zealand Maori
◯ Pacific Islander
◯ Asian
◯ Other (please describe): ______________________________________

4. What is your gender?

◯ Male
◯ Female

5. What is the highest qualification you have achieved?

◯ High school attendance
◯ School certificate or NCEA Level 1
◯ University Entrance, Bursary or NCEA level 3
◯ Tertiary certificate or diploma (not a degree)
◯ Bachelor's degree - For example: BA, BSc
◯ Postgraduate - For example: Honours, Masters, PhD or postgraduate diploma

6. How many hours a week do you spend studying and/or working (paid or volunteer)?

◯ Not applicable
◯ less than 20 hours 20 -29 hours
◯ 30 - 39 hours
◯ 40 - 49 hours
◯ 50 - 59 hours
◯ 60 or more hours

7. Have you ever seen a doctor or other professional about your memory difficulties?

◯ Yes (if yes, please indicate month and year): ____
◯ No

8. Have you ever experienced any kind of neurological event (such as a brain injury, stroke, or epilepsy)? Please select all that apply.

◯ Traumatic brain injury
◯ Stroke
◯ Epilepsy
◯ One or more seizures (not diagnosed as epilepsy)
◯ Brain tumour
◯ Neurological condition (such as Parkinson's disease, Huntington's disease, or multiple sclerosis)
◯ Other (Please describe): ____
◯ None

9. How has your mood generally been over the last 6 months? (Please circle)

Excellent Good Fair Poor / bad

10. How stressed have you been over the last 6 months?

Not stressed at all A little stressed Quite stressed Very stressed

11. Please indicate the quality of social support that is available to you.

Excellent Good Fair Poor / Bad

12. Please rate your general physical health in relation to others your age.

Excellent Good Fair Poor / Bad

13. Please rate your general level of physical exercise in relation to others your age.

Excellent Good Fair Poor / Bad

Section B- Memory Difficulties

Difficulty 1

14. When you think about your memory in everyday life, what is the biggest difficulty (if any) that you have? (For example, forgetting a friend's name, or what you came to the supermarket to buy). ***Please try to be as clear and specific as you can.***

____

____

____

____

15. Thinking about this particular memory difficulty, please rate how much of a problem it is for you in everyday life.

Not a problem at all			Sometimes a problem			One of my biggest problems
1	2	3	4	5	6	7

Now please describe any other memory difficulties you have in everyday life (if any), and rate how much of a problem they are for you.

Only fill in as many memory difficulties as you have, you do not need to fill in all options if they are not relevant for you.

Please add any difficulties and rate them in the sections below.

16. Difficulty 2

____

____

____

____

17. How much of a problem is 'Difficulty 2' for you in everyday life?

Not a problem at all			Sometimes a problem			One of my biggest problems
1	2	3	4	5	6	7

18. Difficulty 3

____

____

____

____

19. How much of a problem is 'Difficulty 3' for you in everyday life?

Not a problem at all			Sometimes a problem			One of my biggest problems
1	2	3	4	5	6	7

----

20. Difficulty 4

____

____

____

____

21. How much of a problem is 'Difficulty 4' for you in everyday life?

Not a problem at all			Sometimes a problem			One of my biggest problems
1	2	3	4	5	6	7

21. Difficulty 5

____

____

____

____

22. How much of a problem is 'Difficulty 5' for you in everyday life?

Not a problem at all			Sometimes a problem			One of my biggest problems
1	2	3	4	5	6	7

----

23. Difficulty 6

____

____

____

____

24. How much of a problem is 'Difficulty 6' for you in everyday life?

Not a problem at all			Sometimes a problem			One of my biggest problems
1	2	3	4	5	6	7

25. Difficulty 7

____

____

____

____

26. How much of a problem is 'Difficulty 7' for you in everyday life?

Not a problem at all			Sometimes a problem			One of my biggest problems
1	2	3	4	5	6	7

Section C- Examples of Memory Difficulties

Below is a list of possible memory difficulties. Some of these may be the same or similar to the difficulties you listed above.
For each example, please indicate how much of a problem it is for you.

	Not a problem at all			Sometimes a problem			One of my biggest problems
Trouble remembering details of what you have been reading (in a newspaper article or book for example)	1	2	3	4	5	6	7
Losing track of what you were doing partway through a task (eg. walking into another room and forgetting what you went there to do).	1	2	3	4	5	6	7
Not keeping up to date with correspondences or paying bills on time.	1	2	3	4	5	6	7
Forgetting an important date (such as someone's birthday or an anniversary).	1	2	3	4	5	6	7
Forgetting appointments.	1	2	3	4	5	6	7
Trouble remembering where you have put things (eg. keys, glasses).	1	2	3	4	5	6	7
Trouble remembering the names of people you have met	1	2	3	4	5	6	7
Trouble thinking of a word that you want to use eg. it might be "on the tip of your tongue"	1	2	3	4	5	6	7
Forgetting what you came to the supermarket/shops to buy.	1	2	3	4	5	6	7
Forgetting what it was that you wanted to say in a conversation.	1	2	3	4	5	6	7
Deciding to do something in a few minutes' time but then forgetting to do it.	1	2	3	4	5	6	7
Forgetting to do routine tasks or chores (such as turning off the oven, or taking medication).	1	2	3	4	5	6	7
Forgetting to pass on a message.	1	2	3	4	5	6	7
Trouble remembering details from a conversation or something you were told a few minutes ago.	1	2	3	4	5	6	7

	Not a problem at all			Sometimes a problem			One of my biggest problems
Trouble remembering something that happened or that you were told yesterday or a few days ago.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Not recognising places even though you have been to them before.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Telling someone something (eg. a story or joke) you have already told them, or asking the same question several times.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Trouble remembering phone numbers you use often.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Forgetting to do something that is a departure from your usual routine.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Not recognising people by sight (could be friends, acquaintances or characters on a TV show for example).	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Getting lost on a journey or walk you have often been on.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Doing something twice by mistake (eg. taking medication, feeding a pet).	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Trouble remembering when things happened in your life.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Trouble remembering how to do something new (eg. how to operate a new gadget or device).	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Prize draw & further research

Thank you for your responses, you have completed the questionnaire! Please indicate below whether you would like to:

- enter the prize draw for a $100 voucher
- be contacted about participating in the second stage of this study
- receive a summary of the study's results when they become available

Would you like to be entered into the prize draw for a $100 voucher for either groceries or books (winner's choice!)?

◯ Yes ◯ No

The second stage of this research will involve looking at the relationship between peoples' responses on this survey and their performance on formal tests of memory functioning. Sometimes, the everyday memory difficulties that people report do not qualify as actual impairment on these tests, and we want to understand this discrepancy.

In this stage of the research, we will be inviting some participants to take part in formal memory tests. People often find that participating in memory tests can be helpful in understanding their memory better, and in developing strategies to improve or compensate for any difficulties. Participating in this stage involves one-on-one testing, either at the Massey University Psychology Clinic in Wellington, or another location that suits you. You will be reimbursed for any associated travel costs, and the testing itself is free of charge.

I can be contacted about participating in the second stage of this research.

◯ Yes ◯ No

Would you like to receive a summary of the findings of this research project?
These will be available by approximately December 2014.

◯ Yes ◯ No

If you answered 'Yes' to participating in a prize draw, participating in a secondary stage of this study, or being provided with a summary of results, please provide your contact details below.

Name: ____

Phone: ____

Mobile: ____

Email: ____

Thank you very much for completing this questionnaire, your help with this research is very much appreciated ☺

Appendix G. Existing scales assessing subjective memory complaints

Everyday Memory Measure (Sunderland et al., 1983)

Rating Scales for Questionnaire Presentations

Sections A to D

(4) Several times in a day.
(3) About once each day.
(2) Once or twice in a week.
(1) Less than once a week.
(0) Never.

Section E

(4) On every occasion.
(3) On every other occasion.
(2) Only sometimes.
(1) Very Rarely
(0) Never.

APPENDIX

Questionnaire and Checklist Items

A. Speech

(1) Forgetting the names of friends or relatives or calling them by the wrong names.
(2) Forgetting the names of common things or using the wrong names.
(3) Finding that a word is "on the tip of your tongue." You know what it is but can't quite find it.
(4) Forgetting something you were told a few minutes ago. Perhaps something your wife or a friend has just said.
(5) Forgetting something you were told yesterday or a few days ago.
(6) Repeating something you have just said or asking the same question several times.
(7) Forgetting what you have just said. Maybe saying "What was I talking about?"
(8) Losing track of what someone is trying to tell you. Unable to follow the thread of their conversation.
(9) Starting to say something, then forgetting what it was that you wanted to speak about.
(10) Letting yourself ramble on to speak about unimportant or irrelevant things.
(11) Forgetting to tell somebody something important. Perhaps forgetting to pass on a message or remind someone of something.
(12) Getting the details of what someone has told you mixed up and confused.
(13) Repeating a story or joke you have already told.

B. Reading and Writing

(14) Forgetting the meanings of unusual words.
(15) Forgetting what the sentence you have just read was about and having to re-read it.
(16) Unable to follow the thread of a story. Lose track of what it is about.
(17) Forgetting how to spell words.

C. Faces and Places

(18) Forgetting where you have put something. Losing things around the house.
(19) Failing to recognise friends or relatives by sight.
(20) Failing to recognise television characters or other famous people by sight.
(21) Getting lost or turning in the wrong direction on a journey or walk you have often been on.
(22) Failing to recognise places you are told you've often been to before.
(23) Finding television stories difficult to follow.

D. Actions

(24) Forgetting to do some routine thing which you would normally do once or twice in a day.
(25) Discovering that you have done some routine thing twice by mistake.
(26) Having to go around checking whether you have done everything you meant to do.
(27) Forgetting what you did yesterday or getting the details of what happened mixed up and confused.
(28) Starting to do something, then forgetting what it was you wanted to do. Maybe saying "What am I doing?"
(29) Being absent minded. Doing something which you didn't really intend to do.

E. Learning New Things

(30) Unable to remember the name of someone you met for the first time recently.
(31) Failing to recognise someone you met for the first time recently.
(32) Getting lost on a journey or walk which you've only been on once or twice before.
(33) Unable to pick up a new skill such as a game or working some new gadget after you have practised once or twice.
(34) Unable to cope with a change in your daily routine. Following your old routine by mistake.
(35) Forgetting to keep an appointment.

Cognitive Failures Questionnaire (Broadbent et al., 1982)

The following questions are about minor mistakes which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things have happened to you in the last six months. Please circle the appropriate number.

	Very often	Quite often	Occasionally	Very rarely	Never
1. Do you read something and find you haven't been thinking about it and must read it again?	4	3	2	1	0
2. Do you find you forget why you went from one part of the house to the other?	4	3	2	1	0
3. Do you fail to notice signposts on the road?	4	3	2	1	0
4. Do you find you confuse right and left when giving directions?	4	3	2	1	0
5. Do you bump into people?	4	3	2	1	0
6. Do you find you forget whether you've turned off a light or a fire or locked the door?	4	3	2	1	0
7. Do you fail to listen to people's names when you are meeting them?	4	3	2	1	0
8. Do you say something and realize afterwards that it might be taken as insulting?	4	3	2	1	0
9. Do you fail to hear people speaking to you when you are doing something else?	4	3	2	1	0
10. Do you lose your temper and regret it?	4	3	2	1	0
11. Do you leave important letters unanswered for days?	4	3	2	1	0
12. Do you find you forget which way to turn on a road you know well but rarely use?	4	3	2	1	0
13. Do you fail to see what you want in a supermarket (although it's there)?	4	3	2	1	0
14. Do you find yourself suddenly wondering whether you've used a word correctly?	4	3	2	1	0
15. Do you have trouble making up your mind?	4	3	2	1	0
16. Do you find you forget appointments?	4	3	2	1	0
17. Do you forget where you put something like a newspaper or a book?	4	3	2	1	0
18. Do you find you accidentally throw away the thing you want and keep what you meant to throw away – as in the example of throwing away the matchbox and putting the used match in your pocket?	4	3	2	1	0
19. Do you daydream when you ought to be listening to something?	4	3	2	1	0
20. Do you find you forget people's names?	4	3	2	1	0
21. Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	4	3	2	1	0
22. Do you find you can't quite remember something although it's 'on the tip of your tongue'?	4	3	2	1	0
23. Do you find you forget what you came to the shops to buy?	4	3	2	1	0
24. Do you drop things?	4	3	2	1	0
25. Do you find you can't think of anything to say?	4	3	2	1	0

Prospective and Retrospective Memory Questionnaire (Smith et al., 2000)

QUESTION CATEGORIES AND ORDERING

The figures in brackets indicate the order in which each question (1–16) appeared on the questionnaire. The questions appeared in the same order in each version of the questionnaire. Participants were not informed that the questions belonged to particular categories.

Prospective short-term self-cued
Do you decide to do something in a few minutes' time and then forget to do it? (1)
Do you forget to tell someone something you had meant to mention a few minutes ago? (16)

Prospective short-term environmentally-cued
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? (3)
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? (10)

Prospective long-term self-cued
Do you forget appointments if you are not prompted by someone else or by a reminder such as a calendar or diary? (5)
If you tried to contact a friend or relative who was out, would you forget to try again later? (14)

Prospective long-term environmentally-cued
Do you forget to buy something you planned to buy, like a birthday card, even when you see the shop? (7)
Do you fail to mention or give something to a visitor that you were asked to pass on? (12)

Retrospective short-term self-cued
Do you forget something that you were told a few minutes before? (4)
Do you mislay something, that you have just put down, like a magazine or glasses? (11)

Retrospective short-term environmentally-cued
Do you fail to recognise a character in a radio or television show from scene to scene? (6)
Do you look at something without realising you have seen it moments before? (13)

Retrospective long-term self-cued
Do you fail to recall things that have happened to you in the last few days? (8)
Do you forget what you watched on television the previous day? (15)

Retrospective long-term environmentally-cued
Do you fail to recognise a place you have visited before? (2)
Do you repeat the same story to the same person on different occasions? (9)

INSTRUCTIONS

Carers rating patients
The following questions are about minor memory mistakes which everyone makes from time to time, but some of them happen more often than others. We would like you to tell us how often these things happen to the person you care for. Please indicate this 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.

Carers self-rating
The following questions are about minor memory mistakes which everyone makes from time to time, but some of them happen more often than others. We would like you to tell us how often these things happen to *you*. Please indicate this 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.

Controls
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 this 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.

Married couples self-rating
(As for Controls)

Married couples rating spouse
The following questions are about minor memory mistakes which everyone makes from time to time, but some of them happen more often than others. We would like you to tell us how often in your opinion these things happen to *your spouse*. Please indicate this 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.

I am completing this questionnaire about my husband/wife (circle as appropriate)

Memory Complaint Questionnaire (Crook et al., 1992)

Memory Complaint Questionnaire (MAC-Q)
As compared to when you were in high school or college, how would you describe your ability to perform the following tasks involving your memory?

	Much better now (1)	Somewhat better now (2)	About the same (3)	Somewhat poorer now (4)	Much poorer now (5)
1. Remembering the name of a person just introduced to you					
2. Recalling telephone numbers or zip codes that you use on a daily or weekly basis					
3. Recalling where you have put objects (such as keys) in your home or office					
4. Remembering specific facts from a newspaper or magazine article you have just finished reading					
5. Remembering the item(s) you intended to buy when you arrive at the grocery store or pharmacy					
6. In general, how would you describe your memory as compared to when you were in high school?	(2)	(4)	(6)	(8)	(10)

Total Score ____________

Metamemory Questionnaire – Ability subscale (Troyer & Rich, 2002)

Metamemory Questionnaire-Ability

1. How often do you forget to pay a bill on time? (.56)
2. How often do you misplace something you use daily, like your keys or glasses? (.52)
3. How often do you have trouble remembering a telephone number you just looked up? (.55)
4. How often do you not recall the name of someone you just met? (.54)
5. How often do you leave something behind when you meant to bring it with you? (.60)
6. How often do you forget an appointment? (.53)
7. How often do you forget what you were just about to do; for example, walk into a room and forget what you went there to do? (.67)
8. How often do you forget to run an errand? (.64)
9. How often do you have difficulty coming up with a specific word that you want? (.67)
10. How often do you have trouble remembering details from a newspaper or magazine article you read earlier that day? (.65)
11. How often do you forget to take medication? (.54)
12. How often do you not recall the name of someone you have known for some time? (.64)
13. How often do you forget to pass on a message? (.63)
14. How often do you forget what you were going to say in conversation? (.74)
15. How often do you forget a birthday or anniversary that you used to know well? (.52)
16. How often do you forget a telephone number you use frequently? (.56)
17. How often do you retell a story or joke to the same person because you forgot that you had already told him or her? (.45)
18. How often do you misplace something that you put away a few days ago? (.62)
19. How often do you forget to buy something you intended to buy? (.60)
20. How often do you forget details about a recent conversation? (.54)

Memory Functioning Questionnaire – General Frequency of Forgetting subscale (Gilewski et al., 1990)

Memory Functioning Questionnaire

This is a questionnaire about how you remember information. There are no right or wrong answers. Circle a number between 1 and 7 that best reflects your judgment about your memory. Think carefully about your responses, and try to be as realistic as possible when you make them. Please answer all questions.

General Frequency of Forgetting

How would you rate your memory in terms of the kinds of problems that you have?

major problems			*some minor problems*		*no problems*	
1	2	3	4	5	6	7

How often do these present a problem for you?

	always			*sometimes*			*never*
a. names	1	2	3	4	5	6	7
b. faces	1	2	3	4	5	6	7
c. appointments	1	2	3	4	5	6	7
d. where you put things (e.g., keys)	1	2	3	4	5	6	7
e. performing household chores	1	2	3	4	5	6	7
f. directions to places	1	2	3	4	5	6	7
g. phone numbers you've just checked	1	2	3	4	5	6	7
h. phone numbers you use frequently	1	2	3	4	5	6	7
i. things people tell you	1	2	3	4	5	6	7
j. keeping up correspondence	1	2	3	4	5	6	7
k. personal dates (e.g., birthdays)	1	2	3	4	5	6	7
l. words	1	2	3	4	5	6	7
m. going to the store and forgetting what you wanted to buy	1	2	3	4	5	6	7
n. taking a test	1	2	3	4	5	6	7
o. beginning to do something and forgetting what you were doing	1	2	3	4	5	6	7
p. losing the thread of thought in conversation	1	2	3	4	5	6	7
q. losing the thread of thought in public speaking	1	2	3	4	5	6	7
r. knowing whether you've already told someone something	1	2	3	4	5	6	7

As you are reading a novel, how often do you have trouble remembering what you have read . . .

	always			*sometimes*			*never*
a. in the opening chapters, once you have finished the book	1	2	3	4	5	6	7
b. three or four chapters before the one you are currently reading	1	2	3	4	5	6	7
c. the chapter before the one you are currently reading	1	2	3	4	5	6	7
d. the paragraph just before the one you are currently reading	1	2	3	4	5	6	7
e. the sentence before the one you are currently reading	1	2	3	4	5	6	7

When you are reading a newspaper or magazine article, how often do you have trouble remembering what you have read . . .

	always			*sometimes*			*never*
a. in the opening paragraphs, once you have finished the article	1	2	3	4	5	6	7
b. three or four paragraphs before the one you are currently reading	1	2	3	4	5	6	7
c. the paragraph before the one you are currently reading	1	2	3	4	5	6	7
d. three or four sentences before the one you are currently reading	1	2	3	4	5	6	7
e. the sentence before the one you are currently reading	1	2	3	4	5	6	7

cluding depression, than with cognitive function. In spite of these, there are increasing evidences that it might be associated with the risk of dementia [13, 14] and subjects with SMC showed a smaller hippocampal volume and more extensive white matter hyperintensities than those without SMC [15–17]. This suggests that SMC may reflect cognitive decline due to structural brain changes.

In this situation, development of validated questionnaires for SMC is essential to activate SMC research. There are several measures of SMC with various levels of validation [18]. SMC has been assessed by a single question [19, 20] or by questionnaires [10, 11, 21–23]. There are suggestions that using more than 1 question to measure SMC is appropriate because elderly subjects do not view memory as a single entity [18]. Psychometric properties of many self-rated questionnaires for SMC – including the Camdex Memory Complaint Questionnaire (CMCQ) [11] and cognitive questions in the Geriatric Mental State Schedule [4], which were used in the previous studies – were not formally tested [18]. In addition, some of the metamemory scales, for which reliability and validity were established, were too long for general use [22, 23].

For this study, we developed the Subjective Memory Complaints Questionnaire (SMCQ), a brief self-rated questionnaire for SMC, and validated its psychometric properties, including reliability and validity, and its diagnostic ability in detecting dementia.

Subjects and Methods

Construction of the SMCQ

The SMCQ consists of 14 items reflecting various aspects of SMC, including metacognition of general and specific memories. A similar approach was used in the previous studies [24, 25]. An expert consensus panel that consisted of 5 neuropsychiatrists selected the items of the SMCQ from among 59 items used for assessing SMC in the previous studies [4, 10, 15, 21, 26]. Four items of the SMCQ (Do you think that you have a memory problem? Do you think that your memory is worse than 10 years ago? Do you think that your memory is poorer than that of other people of a similar age? Do you feel that your everyday life is difficult due to memory decline?) were designed to assess global memory function, and the other 10 items (Do you have difficulty in remembering a recent event? Do you have difficulty in remembering a conversation from a few days ago? Do you have difficulty in remembering an appointment made a few days ago? Do you have difficulty in recognizing familiar people? Do you have difficulty in remembering where you placed objects? Do you lose objects more often than you did previously? Have you become lost near your home? Do you have difficulty in remembering 2 or 3 items to buy when shopping? Do you have difficulty in remembering to turn off the gas or lights? Do you have difficulty in remembering the phone numbers of your own children?) were designed to assess everyday memory function.

To enhance the feasibility and reliability of each item in the elderly, the subject's responses to each question were restricted to either yes or no. The highest possible total score on the SMCQ is 14 points (SMCQ-T): 4 points for the judgment of global memory (SMCQ-G) and 10 points for everyday memory (SMCQ-E). Higher SMCQ scores are indicative of severer SMC.

Subjects

All of the subjects were community-dwelling Korean elderly aged 65 years and older. They were recruited from either the participants of the Korean Longitudinal Study for Health and Aging (KLoSHA) [27] or the volunteers for the Dementia Screening and Registry Program in Seongnam and Seoul. The KLoSHA is a population-based longitudinal study on health, aging and common geriatric diseases in Korean elderly aged 65 years and older, and it was conducted between September 2005 and September 2006 in Seongnam, the biggest satellite city of Seoul, Korea [27]. The subjects of the KLoSHA consist of 714 subjects who were randomly sampled and 272 subjects who volunteered. Among the 714 randomly sampled subjects, 692 subjects completed the SMCQ. The Dementia Screening and Registry Program subjects comprised 687 volunteers. In total, the study sample consisted of 692 randomly sampled subjects and 959 volunteers.

All of the subjects who participated in this study were fully informed regarding study participation, and informed consent was obtained from each subject or their legal guardians. The study protocol was approved by the Institutional Review Board of Seoul National University Bundang Hospital.

Clinical and Neuropsychological Assessment

All of the subjects were subjected to a standardized clinical interview and physical/neurological examinations, which were administered by a neuropsychiatrist with advanced training in dementia research in accordance with the protocol of the Korean version of the CERAD (Consortium to Establish a Registry for Alzheimer's Disease) clinical assessment battery [28].

To examine the validity of the SMCQ, the CMCQ [10, 11], Seoul Informant Report Questionnaire for Dementia (SIRQD) [28], and standardized Korean version of the CERAD Neuropsychological Assessment Battery (CERAD-K-N) [29] were coadministered with the SMCQ. The CMCQ consists of 1 question for assessing global memory and 3 questions for assessing everyday memory. The SIRQD is an informant-reported questionnaire that consists of 15 questions assessing remote and recent memory, language, and activities of daily living functioning of the subject [28]. The CERAD-K-N includes a word list memory test, a word list recall test and a word list recognition test for verbal episodic memory, construction recall for visual memory, the verbal fluency test and the 15-item modified Boston Naming Test for semantic memory and language, the Mini-Mental State Examination (MMSE) for global cognition, and a constructional praxis test for constructional functions.

The Korean version of the Geriatric Depression Scale [30] was also administered for the evaluation of concomitant depressive symptoms.

The diagnoses of dementia and major psychiatric disorders and Clinical Dementia Rating (CDR) [31] were made by a panel of 4 neuropsychiatrists with expertise in dementia research. Two of

Subjective Memory Questionnaire (Squire et al., 1979)

Table I. Self-Rating Scale of Memory Function[a]

1. My ability to search through my mind and recall names or memories I know are there is
2. I think my relatives and acquaintances now judge my memory to be
3. My ability to recall things when I really try is
4. My ability to hold in my memory things that I have learned is
5. If I were asked about it a month from now, my ability to remember facts about this form I am filling out would be
6. The tendency for a past memory to be "on the tip of my tongue," but not available to me is
7. My ability to recall things that happened a long time ago is
8. My ability to remember the names and faces of people I meet is
9. My ability to remember what I was doing after I have taken my mind off it for a new minutes is
10. My ability to remember things that have happened more than a year ago is
11. My ability now to remember what I read and what I watch on television is
12. My ability to recall things that happened during my childhood is
13. My ability to know when the things I am paying attention to are going to stick in my memory is
14. My ability to make sense out of what people explain to me is
15. My ability to reach back in my memory and recall what happened a few minutes ago is
16. My ability to pay attention to what goes on around me is
17. My general alertness to things happening around me is
18. My ability to follow what people are saying is

[a] Each item began with the statement "compared to before I began to feel bad and went to the hospital. . ." Thus, both therefore ECT and after ECT patients were asked to rate their memory now compared to before they began to feel bad. In this way, the before-ECT test attempted to assess memory problems of recent onset, presumably related to depression. After-ECT tests attempted to assess residual effects of depression and the effects of ECT on memory. For each item, patients rated themselves on a 9-point scale ranging from −4 (worse than ever before), through 0 (same as before) to +4 (better than ever before). Here the items have been ordered according to the magnitude of the difference in score obtained before ECT and 1 week after ECT (Fig. 1). Item 1 produced the largest difference, and Item 18 produced the smallest difference.

Classification instrument for spontaneously reported cognitive complaints developed by Apolinario et al. (2012)

Table 2. Final version of the classification instrument, with proportion of patients reporting complaints in each category and corresponding inter-rater reliability

		N (%)	κ
Temporal orientation		10 (5.6)	0.97
T1	Difficulty remembering the current date.	9 (5.0)	
T2	Difficulty remembering when events happened.	2 (1.1)	
Attention		83 (46.1)	0.85
A1	Getting distracted and forgetting what one was going to do next.	37 (20.6)	0.98
A2	Burning food because of forgetting to turn off the stove or oven.	34 (18.9)	1.00
A3	Distractions in everyday tasks (forgetting to lock doors, switch off appliances, add sugar to coffee).	19 (10.6)	0.79
A4	Losing objects when going out (umbrellas, cell phones, keys, bags).	4 (2.2)	
A5	Difficulty maintaining concentration (on conversations, TV programs, reading).	7 (3.9)	
A6	Difficulty returning to a task after being interrupted.	2 (1.1)	
A7	Difficulty performing two tasks at the same time.	1 (0.6)	
Retrospective memory		113 (62.8)	0.83
R1	Forgetting where one has placed objects (keys, glasses, documents, money).	63 (35.0)	0.98
R2	Forgetting about recent conversations (includes asking the same question repeatedly).	27 (15.0)	0.96
R3	Forgetting personal information (passwords, telephone number, home address, birth date).	17 (9.4)	0.79
R4	Forgetting information about what has been read.	11 (6.2)	0.91
R5	Forgetting things that happened recently (outings, meetings, and family events).	8 (4.4)	
R6	Forgetting whether one has already performed a task (pay bills, take medicines).	6 (3.3)	
R7	Forgetting information about what was being watched on TV or listened on radio.	4 (2.2)	
R8	Forgetting that one has already told something (includes telling the same story repeatedly).	3 (1.7)	
R9	Difficulty recognizing people.	2 (1.1)	
Prospective memory		74 (41.1)	0.89
P1	Forgetting appointments or meetings.	31 (17.2)	1
P2	Forgetting to buy intended items when shopping.	16 (8.9)	0.93
P3	Forgetting to deliver a message.	15 (8.3)	0.95
P4	Forgetting to take medicines.	14 (7.8)	0.90
P5	Forgetting to do household chores.	10 (5.6)	0.80
P6	Forgetting birthdays or anniversaries.	6 (3.3)	
P7	Forgetting to pay bills on time.	4 (2.2)	
Language		57 (31.7)	0.92
L1	Difficulty with recalling people's names.	40 (22.2)	0.97
L2	Difficulty finding the right words in conversation.	13 (7.2)	0.89
L3	Difficulty with recalling the names of objects, places, and streets.	6 (3.3)	
L4	Difficulty understanding what is being said (on conversations, TV, or radio programs).	2 (1.1)	
L5	Difficulty understanding what is being read.	1 (0.6)	
Visuospatial skills		25 (13.9)	0.95
V1	Difficulty finding one's way on the streets (when driving or walking).	23 (12.8)	0.93
V2	Difficulty finding one's way inside a building.	1 (0.6)	
Executive functions		21 (11.7)	0.84
E1	Difficulty performing activities that involve planning, organization, and require several steps.	6 (3.3)	
E2	Difficulty performing calculations.	3 (1.7)	
E3	Difficulty managing finances.	2 (1.1)	
E4	Difficulty operating electronic devices (household appliances, ATM machines).	4 (2.2)	
E5	Difficulty with reasoning for solving problems.	1 (0.6)	

Appendix H. Creation of subjective memory complaints questionnaire

Content analysis of the items from each questionnaire resulted in 61 categories, of which 33 contained more than one item. These 33 categories were each represented by a single item in the newly created questionnaire, except when:

4. the category was already represented by an earlier item (e.g., the category "directions" was represented by the earlier category of "getting lost")
5. the category referred to general memory changes rather than a specific example of difficulty (e.g., "change over time")
6. the category represented a difficulty which was clearly related to some cognitive aspect other than memory (e.g., "insult someone accidentally").

This process resulted in a total of 24 categories each represented by a single item, which comprised the new questionnaire.

Table H1 below shows each item from the original questionnaires with their coded categories.

Table H1. Content Analysis of Existing Questionnaires

Category	Item	Source
Alertness	My general alertness to things happening around me is…	Squire et al. (1979)
Answer correspondence	How often do you forget to pay a bill on time?	Troyer and Rich (2002)
	Keeping up correspondences	Gilewski et al. (1990)
	Do you leave important letters unanswered for days?	Broadbent et al. (1982)
	Forgetting to pay bills on time.	Apolinario et al. (2012)
Appointments	How often do you forget an appointment?	Troyer and Rich (2002)
	Appointments	Gilewski et al. (1990)
	Do you find you forget appointments?	Broadbent et al. (1982)
	Do you forget appointments if you are not prompted by someone else or by a reminder such as a calendar or diary?	Smith et al. (2000)

Category	Item	Source
	Do you have difficulty in remembering an appointment made a few days ago?	Youn et al. (2009)
	Forgetting to keep an appointment.	Sunderland et al. (1983)
	Forgetting appointments or meetings.	Apolinario et al. (2012)
Attention	My ability to pay attention to what goes on around me is…	Squire et al. (1979)
Birthdays	How often do you forget a birthday or anniversary that you used to know well?	Troyer and Rich (2002)
	Personal dates (eg. birthdays)	Gilewski et al. (1990)
	Forgetting birthdays or anniversaries.	Apolinario et al. (2012)
Bump into people	Do you bump into people?	Broadbent et al. (1982)
Change over time	In general, how would you describe your memory as compared to when you were in high school?	Crook et al. (1992)
	Do you think that your memory is worse than 10 years ago?	Youn et al. (2009)
Childhood	My ability to recall things that happened during my childhood is…	Squire et al. (1979)
Compared to others	Do you think that your memory is poorer than that of other people of a similar age?	Youn et al. (2009)
Conversation	My ability to make sense out of what people explain to me is…	Squire et al. (1979)
	How often do you forget details about a recent conversation?	Troyer and Rich (2002)
	Things people tell you	Gilewski et al. (1990)
	Do you forget something that you were told a few minutes before?	Smith et al. (2000)
	Do you think that your difficulty in remembering a conversation from a few days ago?	Youn et al. (2009)
	Getting the details of what someone has told you mixed up and confused.	Sunderland et al. (1983)
	Losing track of what someone is trying to tell you. Unable to follow the thread of the conversation.	Sunderland et al. (1983)
	Forgetting about recent conversations (includes asking the same question repeatedly).	Apolinario et al. (2012)
	Difficulty understanding what is being said (on conversations, TV, or radio programs).	Apolinario et al. (2012)

Category	Item	Source
Directions	Directions to places	Gilewski et al. (1990)
	Do you find you confuse right and left when giving directions?	Broadbent et al. (1982)
	Difficulty finding one's way on the streets.	Apolinario et al. (2012)
	Difficulty finding one's way inside a building.	Apolinario et al. (2012)
Distraction	Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	Broadbent et al. (1982)
Do things by mistake	Do you find you accidentally throw away the thing you you want and keep what you meant to throw away - as in the example of throwing away the matchbox and putting the used match in your pocket?	Broadbent et al. (1982)
	Discovering that you have done some routine thing twice by mistake.	Sunderland et al. (1983)
	Being absent minded. Doing something which you didn't really intend to do.	Sunderland et al. (1983)
	Forgetting whether one has already performed a task (pay bills, take medicines).	Apolinario et al. (2012)
Drop things	Do you drop things?	Broadbent et al. (1982)
Effort	My ability to recall things when I really try is…	Squire et al. (1979)
Errands	How often do you forget to run an errand?	Troyer and Rich (2002)
	Performing household chores	Gilewski et al. (1990)
	Unable to cope with a change in your daily routine. Following your old routine by mistake.	Sunderland et al. (1983)
	Forgetting to do household chores.	Apolinario et al. (2012)
Everyday impact	Do you feel that your everyday life is difficult due to memory decline?	Youn et al. (2009)
Executive functioning	Difficulty performing activities that involve planning, organisation, and require several steps.	Apolinario et al. (2012)
Faces	Faces	Gilewski et al. (1990)
	Do you fail to recognise a character in a radio or television show from scene to scene?	Smith et al. (2000)
	Do you have difficultyin recognising familiar people?	Youn et al. (2009)
	Failing to recognise friends or relatives by sight.	Sunderland et al. (1983)

Category	Item	Source
	Failing to recognise television characters or other famous people by sight.	Sunderland et al. (1983)
	Failing to recognise someone you met for the first time recently.	Sunderland et al. (1983)
	Finding television stories difficult to follow.	Sunderland et al. (1983)
	Difficulty recognising people.	Apolinario et al. (2012)
Facts	My ability to hold in my memory things that I have learned is…	Squire et al. (1979)
Finances	Difficulty managing finances.	Apolinario et al. (2012)
Getting lost	Do you find you forget which way to turn on a road you know well but rarely use?	Broadbent et al. (1982)
	Have you become lost near your home?	Youn et al. (2009)
	Getting lost or turning in the wrong direction on a journey or walk you have often been on.	Sunderland et al. (1983)
	Getting lost on a journey or walk which you've only been on once or twice before.	Sunderland et al. (1983)
Historical	My ability to recall things that happened a long time ago is…	Squire et al. (1979)
I tell the same story	How often do you retell a story or joke to the same person because you forgot that you had already told him or her?	Troyer and Rich (2002)
	Knowing whether you've already told someone something	Gilewski et al. (1990)
	Do you repeat the same story to the same person on different occasions?	Smith et al. (2000)
	Repeating something you have just said or asking the same question several times.	Sunderland et al. (1983)
	Repeating a story or joke you have already told.	Sunderland et al. (1983)
	Forgetting that one has already told something (includes telling the same story repeatedly).	Apolinario et al. (2012)
Insult someone accidentally	Do you say something and realise afterwards that it might be taken as insulting?	Broadbent et al. (1982)
	Lettingyourself ramble on to speak about unimportant or irrelevant things.	Sunderland et al. (1983)
Know when I will remember something	My ability to know when the things I am paying attention to are going to stick in my memory is...	Squire et al. (1979)
Last few days	Do you fail to recall things that have happened to you in the last few days?	Smith et al. (2000)

Category	Item	Source
	Do you have diffiulty in remembering a recent event?	Youn et al. (2009)
	Forgetting something you were told yesterday or a few days ago.	Sunderland et al. (1983)
	Forgetting things that happened recently (outings, meetings, and family events).	Apolinario et al. (2012)
Leave things behind	How often do you leave something behind when you meant to bring it with you?	Troyer and Rich (2002)
Lose my temper	Do you lose your temper and regret it?	Broadbent et al. (1982)
Make up my mind	Do you have trouble making up your mind?	Broadbent et al. (1982)
Mathematics	Difficulty performing calculations.	Apolinario et al. (2012)
More than one year ago	My ability to remember things that have happened more than a year ago is…	Squire et al. (1979)
Multi-tasking	Do you fail to hear people speaking to you when you are doing something else?	Broadbent et al. (1982)
	Difficulty performing two tasks at the same time.	Apolinario et al. (2012)
Names	My ability to remember the names and faces of people I meet is…	Squire et al. (1979)
	How often do you not recall the name of someone you just met?	Troyer and Rich (2002)
	How often do you not recall the name of someone you have known for some time?	Troyer and Rich (2002)
	Names	Gilewski et al. (1990)
	Remembering the name of a person just introduced to you.	Crook et al. (1992)
	Do you find you forget people's names?	Broadbent et al. (1982)
	Do you fail to listen to people's names when you are meeting them?	Broadbent et al. (1982)
	Forgetting the names of friends or relative or calling them by the wrong names.	Sunderland et al. (1983)
	Unable to remember the name of someone you met for the first time recently.	Sunderland et al. (1983)
	Difficulty with recalling people's names.	Apolinario et al. (2012)
	Difficulty with recalling the names of objects, places, and streets.	Apolinario et al. (2012)
New skill	Unable to pick up a new skill such as a game or working some new gadget after you have	Sunderland et al. (1983)

Category	Item	Source
	practised once or twice.	
	Difficulty operating electronic devices (household appliances, ATM machines).	Apolinario et al. (2012)
Not listening	My ability to follow what people are saying is…	Squire et al. (1979)
	Do you daydream when you ought to be listening to something?	Broadbent et al. (1982)
Nothing to say	Do you find you can't think of anything to say?	Broadbent et al. (1982)
Others' views	I think my relatives and acquaintances now judge my memory to be…	Squire et al. (1979)
Overall memory problem	Do you think that you have a memory problem?	Youn et al. (2009)
Pass on a message	How often do you forget to pass on a message?	Troyer and Rich (2002)
	Do you fail to mention or give something to a visitor that you were asked to pass on?	Smith et al. (2000)
	Forgetting to tell somebody something important. Perhaps forgetting to pass on a message or remind someone of something.	Sunderland et al. (1983)
	Forgetting to deliver a message.	Apolinario et al. (2012)
Phone numbers	How often do you have trouble remembering a telephone number you just looked up?	Troyer and Rich (2002)
Phone numbers	How often do you forget a telephone number you use frequently?	Troyer and Rich (2002)
Phone numbers	Phone numbers you've just checked	Gilewski et al. (1990)
Phone numbers	Phone numbers you use frequently	Gilewski et al. (1990)
Phone numbers	Recalling telephone numbers or zip codes that you use on a daily or weekly basis.	Crook et al. (1992)
Phone numbers	Do you have difficultyin remembering the phone numbers of your own children?	Youn et al. (2009)
Phone numbers	Forgetting personal information (passwords, telephone number, home address, birth date).	Apolinario et al. (2012)
Problem solving	Difficulty with reasoning for solving problems.	Apolinario et al. (2012)
Prospective long-term self-cue	If you tried to contact a friend or relative who was out, would you forget to try again later?	Smith et al. (2000)
Prospective long-term self-cue	Having to go around checking whether you have done everything you meant to do.	Sunderland et al. (1983)
Prospective short-term environmental cue	How often do you forget to take medication?	Troyer and Rich (2002)

Category	Item	Source
Prospective short-term environmental cue	Do you find you forget whether you've turned off a light or a fire or locked the door?	Broadbent et al. (1982)
Prospective short-term environmental cue	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?	Smith et al. (2000)
Prospective short-term environmental cue	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?	Smith et al. (2000)
Prospective short-term environmental cue	Do you have difficulty in remembering to turn off the gas or lights?	Youn et al. (2009)
Prospective short-term environmental cue	Forgetting to do some routine thing which you would normally do once or twice in a day.	Sunderland et al. (1983)
Prospective short-term environmental cue	Burning food because of forgetting to turn off the stove or oven.	Apolinario et al. (2012)
Prospective short-term environmental cue	Distractions in everyday tasks (forgetting to lock doors, switch off appliances, add sugar to coffee).	Apolinario et al. (2012)
Prospective short-term environmental cue	Forgetting to take medicines.	Apolinario et al. (2012)
Prospective short-term self-cue	Do you decide to do something in a few minutes' time and then forget to do it?	Smith et al. (2000)
Prospective short-term self-cue	Difficulty returning to a task after being interrupted.	Apolinario et al. (2012)
Public speaking	Losing the thread of thought in public speaking	Gilewski et al. (1990)
Reading	If I were asked about it a month from now, my ability to remember facts about this form I am filling out would be…	Squire et al. (1979)
Reading	My ability now to remember what I read and watch on television is…	Squire et al. (1979)
Reading	How often do you have trouble remembering details from a newspaper or magazine article you read earlier that day?	Troyer and Rich (2002)
Reading	Remembering the opening chapters once you have finished the book	Gilewski et al. (1990)
Reading	Remembering the opening chapters once you have finished the article	Gilewski et al. (1990)
Reading	Three or four chapters before the one you are currently reading (book)	Gilewski et al. (1990)
Reading	The chapter before the one you are currently	Gilewski et al. (1990)

Category	Item	Source
	reading (book)	
Reading	The paragraph before the one you are currently reading (book)	Gilewski et al. (1990)
Reading	The sentence before the one you are currently reading (book)	Gilewski et al. (1990)
Reading	Three or four paragraphs before the one you are currently reading (article)	Gilewski et al. (1990)
Reading	The paragraph before the one you are currently reading (article)	Gilewski et al. (1990)
Reading	Three or four sentences before the one you are currently reading (article)	Gilewski et al. (1990)
Reading	The sentence before the one you are currently reading (article)	Gilewski et al. (1990)
Reading	Remembering specific facts from a newspaper or magazine article you have just finished reading.	Crook et al. (1992)
Reading	Do you read something and find you haven't been thinking about it and must read it again?	Broadbent et al. (1982)
Reading	Forgetting what the sentence you have just read was about and having to reread it.	Sunderland et al. (1983)
Reading	Unable to follow the track of a story. Lose track of what it is about.	Sunderland et al. (1983)
Reading	Forgetting information about what has been read.	Apolinario et al. (2012)
Reading	Difficulty maintaining concentration (on conversations, TV programs, reading).	Apolinario et al. (2012)
Reading	Difficulty understanding what is being read.	Apolinario et al. (2012)
Retrospective long-term environmental cue	Do you fail to recognise a place you have visited before?	Smith et al. (2000)
Retrospective long-term environmental cue	Failing to recognise places you are told you've often been to before.	Sunderland et al. (1983)
Retrospective long-term self-cue	Do you forget what you watched on television the previous day?	Smith et al. (2000)
Retrospective long-term self-cue	Forgetting what you did yesterday or getting the details of what happened mixed up and confused.	Sunderland et al. (1983)
Retrospective long-term self-cue	Forgetting information about what was being watched on TV or listened on radio.	Apolinario et al. (2012)
Retrospective short-term environmental cue	My ability to reach back in my memory and recall what happened a few minutes ago is…	Squire et al. (1979)

Category	Item	Source
Retrospective short-term environmental cue	Do you look at something without realising you have seen it moments before?	Smith et al. (2000)
Retrospective short-term environmental cue	Forgetting something you were told a few minutes ago. Perhaps something your wife or a friend has just said.	Sunderland et al. (1983)
Search for known facts	My ability to search through my mind and recall names or memories I know are there is…	Squire et al. (1979)
See supermarket item	Do you fail to see what you want in a supermarket (even though it's there)?	Broadbent et al. (1982)
Signposts	Do you fail to notice signposts on the road?	Broadbent et al. (1982)
Temporality	Difficulty remembering the current date.	Apolinario et al. (2012)
Temporality	Difficulty remembering when events happened.	Apolinario et al. (2012)
Tests	Taking a test	Gilewski et al. (1990)
Tip of the tongue	The tendency for a past memory to be "on the tip of my tongue" but not available to me is…	Squire et al. (1979)
Tip of the tongue	Do you find you can't quite remember something although it's 'on the tip of your tongue'?	Broadbent et al. (1982)
Tip of the tongue	Finding that a word is "on the tip of your tongue". You know what it is but can't quite find it.	Sunderland et al. (1983)
What I was going to say	How often do you forget what you were going to say in conversation?	Troyer and Rich (2002)
What I was going to say	Losing the thread of thought in conversation	Gilewski et al. (1990)
What I was going to say	Do you forget to tell someone something you had meant to mention a few minutes ago?	Smith et al. (2000)
What I was going to say	Forgetting what you have just said. Maybe saying "What was I talking about?"	Sunderland et al. (1983)
What I was going to say	Starting to say something, then forgetting what it was that you wanted to speak about.	Sunderland et al. (1983)
What to buy	How often do you forget to buy something you intended to buy?	Troyer and Rich (2002)
What to buy	Going to the store and forgetting what you wanted to buy	Gilewski et al. (1990)
What to buy	Remembering the item(s) you intended to buy when you arrived at the grocery store or pharmacy.	Crook et al. (1992)
What to buy	Do you find you forget what you came to the shops to buy?	Broadbent et al. (1982)
What to buy	Do you forget to buy something you planned to buy, like a birthday card, even when you see the	Smith et al. (2000)

Category	Item	Source
	shop?	
What to buy	Do you have difficuly in remembering 2 or 3 items to buy when shopping?	Youn et al. (2009)
What to buy	Forgetting to buy intended items when shopping.	Apolinario et al. (2012)
Where I put things	How often do you misplace something you use daily, like your keys or glasses?	Troyer and Rich (2002)
Where I put things	How often do you misplace something that you put away a few days ago?	Troyer and Rich (2002)
Where I put things	Where you put things	Gilewski et al. (1990)
Where I put things	Recalling where you have put objects (such as keys) in your home or office).	Crook et al. (1992)
Where I put things	Do you forget where you put something like a newspaper or book?	Broadbent et al. (1982)
Where I put things	Do you mislay something, that you have just put down, like a magazine or glasses?	Smith et al. (2000)
Where I put things	Do you lose objects more often than you did previously?	Youn et al. (2009)
Where I put things	Do you have difficulty in remembering where you placed objects?	Youn et al. (2009)
Where I put things	Forgetting where you have put something. Losing things around the house.	Sunderland et al. (1983)
Where I put things	Forgetting where one has placed objects (keys, glasses, documents, money).	Apolinario et al. (2012)
Where I put things	Losing objects when going out (umbrellas, cell phones, keys, bags).	Apolinario et al. (2012)
Why I came in the room	My ability to remember what I was doing after I have taken my mind off it for a few minutes is…	Squire et al. (1979)
Why I came in the room	How often do you forget what you were just about to do; for example, walk into a room and forget what you went there to do?	Troyer and Rich (2002)
Why I came in the room	Beginning to do something and forgetting what you were doing	Gilewski et al. (1990)
Why I came in the room	Do you find you forget why you went from one part of the house to the other?	Broadbent et al. (1982)
Why I came in the room	Starting to do something, then forgetting what it was you wanted to do. Maybe saying "What am I doing?"	Sunderland et al. (1983)
Why I came in the room	Getting distracted and forgetting what one was going to do next.	Apolinario et al. (2012)

Category	Item	Source
Words	How often do you have difficulty coming up with a specific word that you want?	Troyer and Rich (2002)
Words	Words	Gilewski et al. (1990)
Words	Do you find yourself suddenly wondering whether you've used a word correctly?	Broadbent et al. (1982)
Words	Forgetting the names of common things or using the wrong names.	Sunderland et al. (1983)
Words	Forgetting the meanings of unusual words.	Sunderland et al. (1983)
Words	Forgetting how to spell words.	Sunderland et al. (1983)
Words	Difficulty finding the right words in conversation.	Apolinario et al. (2012)

Table H2 shows the frequency data and inclusion decisions for each category, and the representative items included in the new questionnaire.

Table H2. Frequencies and Questionnaire Inclusion Decisions for Categories of Spontaneously Reported Subjective Memory Complaints.

Category	Frequency	Inclusion decision (exclusion reason)	Item in new questionnaire
Reading	20	Included	Trouble remembering details of what you have been reading (in a newspaper article or book for example)
Names	11	Included	Trouble remembering the names of people you have met
Where I put things	11	Included	Trouble remembering where you have put things (eg. keys, glasses).
Conversation	9	Included	Trouble remembering details from a conversation or something you were told a few minutes ago.
Prospective short-term environmental cue	9	Included	Deciding to do something in a few minutes' time but then forgetting to do it.
Faces	8	Included	Not recognising people by sight (could be friends, acquaintances or characters on a TV show for example).
Appointments	7	Included	Forgetting appointments.

Category	Frequency	Inclusion decision (exclusion reason)	Item in new questionnaire
Phone numbers	7	Included	Trouble remembering phone numbers you use often.
What to buy	7	Included	Forgetting what you came to the supermarket/shops to buy.
Words	7	Included	Trouble thinking of a word that you want to use eg. it might be "on the tip of your tongue"
I tell the same story	6	Included	Telling someone something (eg. a story or joke) you have already told them, or asking the same question several times.
Why I came in the room	6	Included	Losing track of what you were doing partway through a task (eg. walking into another room and forgetting what you went there to do).
What I was going to say	5	Included	Forgetting what it was that you wanted to say in a conversation.
Answer correspondence	4	Included	Not keeping up to date with correspondences or paying bills on time.
Directions	4	Included	Getting lost on a journey or walk you have often been on.
Do things by mistake	4	Included	Doing something twice by mistake (eg. taking medication, feeding a pet).
Errands	4	Included	Forgetting to do something that is a departure from your usual routine.
Getting lost	4	Excluded (covered earlier)	
Last few days	4	Included	Trouble remembering something that happened or that you were told yesterday or a few days ago.
Pass on a message	4	Included	Forgetting to pass on a message.
Birthdays	3	Included	Forgetting an important date (such as someone’s birthday or an anniversary).
Retrospective long-term self-cue	3	Included	Not recognising places even though you have been to them before.
Retrospective short-term environmental cue	3	Excluded (general)	
Tip of the tongue	3	Excluded (covered earlier)	
Change over time	2	Excluded (general)	

Category	Frequency	Inclusion decision (exclusion reason)	Item in new questionnaire
Insult someone accidentally	2	Excluded (non-memory)	
New skill	2	Included	Trouble remembering how to do something new (eg. how to operate a new gadget or device).
Not listening	2	Excluded (non-memory)	
Prospective long-term self-cue	2	Included	Forgetting to do routine tasks or chores (such as turning off the oven, or taking medication).
Prospective short-term self-cue	2	Excluded (covered earlier)	
Retrospective long-term environmental cue	2	Excluded (covered earlier)	
Temporality	2	Included	Trouble remembering when things happened in your life.
Multi-tasking	2	Excluded (non-memory)	
Alertness	1	Excluded (single occurrence)	
Attention	1	Excluded (single occurrence)	
Bump into people	1	Excluded (single occurrence)	
Childhood	1	Excluded (single occurrence)	
Compared to others	1	Excluded (single occurrence)	
Distracted	1	Excluded (single occurrence)	
Drop things	1	Excluded (single occurrence)	
More than one year ago	1	Excluded (single occurrence)	
Everyday impact	1	Excluded (single occurrence)	
Executive functioning	1	Excluded (single occurrence)	

Category	Frequency	Inclusion decision (exclusion reason)	Item in new questionnaire
Facts	1	Excluded (single occurrence)	
Finances	1	Excluded (single occurrence)	
Historical	1	Excluded (single occurrence)	
Know when I will remember something	1	Excluded (single occurrence)	
Leave things behind	1	Excluded (single occurrence)	
Lose my temper	1	Excluded (single occurrence)	
Make up my mind	1	Excluded (single occurrence)	
Mathematics	1	Excluded (single occurrence)	
Nothing to say	1	Excluded (single occurrence)	
Others' views	1	Excluded (single occurrence)	
Overall memory problem	1	Excluded (single occurrence)	
Problem solving	1	Excluded (single occurrence)	
Public speaking	1	Excluded (single occurrence)	
Search for known facts	1	Excluded (single occurrence)	
See supermarket item	1	Excluded (single occurrence)	
Signposts	1	Excluded (single occurrence)	
Tests	1	Excluded (single occurrence)	
Effort	1	Excluded (single occurrence)	

Validity and Reliability

The 24-item questionnaire showed excellent internal reliability, Cronbach's $\alpha = .93$. When responses of 1 ("not at all a problem") were excluded (consistent with the analyses in Chapters 5-7), internal reliability was similarly high, $\alpha = .94$.

A principal components analysis with varimax rotation suggested a single factor solution to the scale, with good sampling adequacy (KMO = .93) and sphericity (Bartlett's $\chi^2(276) = 3904.04$, $p < .001$). A single factor explained 40.05% of the variance in overall scores, with an eigen-value of 9.61.

Appendix I. Survey information sheet

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Memory Difficulties Survey

Who is doing this research?

My name is Bridget Burmester and I am a student at Massey University. I am conducting this research as partial requirement of completing a Doctoral degree in Clinical Psychology. The primary supervisor for this research is Professor Janet Leathem of Massey University's Wellington campus.

What is this research about?

We are interested in what kinds of memory difficulties people experience in their daily lives, and how these relate to their performance on formal tests of memory functioning. As part of this research, we are inviting you to take part in this survey about everyday memory.

Who can participate and what does it involve?

We are recruiting participants via newspaper, magazine and internet advertisements, as well as through the networks of ourselves and various community groups. Anybody over 40 years of age is invited to participate. We aim to recruit at least 400 people, as this number is needed in order to conduct statistically valid and meaningful analyses. This survey should only take 5- 10 minutes of your time.

Participants in this survey can go in the draw to win either a $100 grocery voucher or a $100 book voucher. If you would like to be entered in this draw, please fill in your contact details at the end of this survey.

Participation in this survey may result in heightened awareness of everyday memory difficulties and the distress that may accompany them. However, previous research has shown that over half of middle-aged and older adults consider themselves to be forgetful, and nine out of ten people aged 70-90 report memory difficulties. These rates suggest that memory difficulties are a normal part of ageing. However, if completing this questionnaire raises concerns for you about your memory, you should contact your doctor for advice.

What happens to the information that you provide?

The overall findings will form part of a DClinPsych thesis, which will be submitted for assessment. The overall findings may also be submitted for publication in a scientific journal, or presented at scientific conferences.

Please note that you will never be personally identified in this research project or in any other presentation or publication. The information you provide in this survey will be analysed only as group data.

Data resulting from this research will be securely stored at Massey University for five years, after which it will be destroyed. Data will be viewed only by the researcher, the primary supervisor, and the computer programmer/analyst of the psychology department of Massey University.

What are your rights as a participant?

You are under no obligation to accept this invitation to participate in the survey. Completion and submission of this questionnaire implies consent. You have the right to decline to answer any particular question.

If you would like to know the results of this study, they will be available in approximately December 2014, via information posted or emailed to you upon request.

If you have any further questions regarding this study please ring 0800 MEMORY (0800 636679), leave a message with your contact details, and we will call you back. Alternatively, you can contact either the researcher or the supervisor via the details given below.

Many thanks,
Bridget Burmester.

Contact information

Researcher	Supervisor
Bridget Burmester School of Psychology Massey University Wellington New Zealand 0800 MEMORY (0800 636679) Email: bridgetburmester@gmail.com	Dr Janet Leathem School of Psychology Wellington Campus Massey University Wellington New Zealand +64 4 801-5799 ext 62035 J.M.Leathem@massey.ac.nz

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 13/26. If you have any concerns about the conduct of the research, please contact Dr Nathan Matthews, Chair, Massey University Human Ethics Committee: Southern B, telephone 06 350-5799 x 80877, Email: humanethicssouthb@massey.ac.nz

Respondent Instructions & Consent

Thank you for participating in this study. This questionnaire consists of a series of questions about you and your everyday memory.

The questionnaire should only require 5-10 minutes of your time.

The findings of this study are likely to benefit future research with the aim of helping people who experience memory difficulties. We appreciate your input.

Please complete all the sections if possible. You have the right to not answer any particular question.

Many thanks for your assistance with this survey.

Bridget Burmester

Thank you for participating in this questionnaire. Your participation implies consent.
You have the right to decline to answer any particular question.

I have read and understood the information sheet for this study and consent to collection of my responses.

◯ **Yes**
◯ **No**

Appendix J. Testing information sheet

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Memory Testing - Information Sheet

Who is doing this research?

My name is Bridget Burmester and I am a student at Massey University. I am conducting this research as partial requirement of completing a Doctoral degree in Clinical Psychology. The primary supervisor for this research is Professor Janet Leathem of Massey University's Wellington campus.

What is this research about?

We are interested in what kinds of memory difficulties people experience in their daily lives, and how these relate to their performance on formal tests of memory functioning. Sometimes, the everyday memory difficulties that people report do not qualify as actual impairment on memory tests, and we want to understand this discrepancy. As part of this research, I am inviting you to take part in some memory tests.

Who can participate?

You are invited to participate in this research because you previously completed a survey about memory difficulties and indicated you could be contacted about this opportunity. This second stage of the research involves participating in tests designed to gather information about your memory abilities. We would like to see 70 people who previously completed the survey.

What is involved if you agree to participate?

If you choose to participate in this assessment, you will take part in a number of tests that are designed to gather information about your strengths and weaknesses in relation to your memory. The tests will involve remembering words, numbers, or pictures, and answering a range of questions. The testing is one-on-one with the researcher, takes approximately 60 minutes of your time, and is free of charge. You will also be reimbursed for your time with a $20 petrol or grocery voucher.

Memory difficulties are extremely common among adults of all ages and are a normal part of ageing. Sometimes people can be worried about how they will perform on tests and what the consequences might be. While some of the tests might be somewhat difficult, they are designed to find out what how well you *can* do. Often, people find that participating in memory tests can be helpful in understanding their memory better, and in developing strategies to improve or compensate for any difficulties. You will also be able to discuss the results of the testing in a follow-up feedback session if you wish (either in person, over the phone, or online). We can also provide you with information on how to get further assistance for any significant problems, or aspects of your memory that you are concerned about.

What happens to the information that you provide?

The data you provide will form part of a DClinPsyc thesis, which will be submitted for assessment. The overall findings may also be submitted for publication in a scientific journal, or presented at scientific conferences.

Please note that you will never be identified in this research project or in any other presentation or publication. The information you provide will only be referred to by a random set of initials.

Data resulting from this research will be securely stored at Massey University for five years, after which it will be destroyed. Data will be viewed only by the researcher, the primary supervisor, and the computer programmer/analyst of the psychology department of Massey University.

What are your rights as a participant?

You are under no obligation to accept this invitation to participate in the testing. If you decide to participate, you have the right to:

- decline to answer any particular question
- withdraw from the study at any time before the testing
- ask any questions about the study at any time during participation
- provide information on the understanding that your name will not be used unless you give permission to the researcher
- be given access to a summary of the project findings when it is concluded

If you would like to know the results of this study, they will be available in approximately December 2015, via information posted or emailed to you upon request.

If you have any further questions regarding this study please contact either the researcher or the supervisor, or phone 0800 MEMORY (0800 636679).

What do you do if you want to participate?

*Please phone **0800 MEMORY** (0800 636679), leave a message with your name and contact details, and we will get back to you as soon as possible.*

Many thanks,
Bridget Burmester.

<table>
<tr><td>Researcher: Bridget Burmester</td><td>Supervisor: Professor Janet Leathem</td></tr>
<tr><td colspan="2" align="center">School of Psychology
Wellington Campus
Massey University
New Zealand</td></tr>
<tr><td>Phone: 0800 MEMORY (0800 636679)
Email: bridgetburmester@gmail.com</td><td>Telephone: (04) 801 5799, ext 62035
Email: J.M.Leathem@massey.ac.nz</td></tr>
</table>

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application __/__ *(insert application number).* If you have any concerns about the conduct of this research, please contact Dr Nathan Matthews, Chair, Massey University Human Ethics Committee: Southern B, telephone 06 350 5799 x 80877, email humanethicsouthb@massey.ac.nz

Appendix K. Testing consent form

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Understanding Subjective Memory Complaints: Assessment and Aetiology

PARTICIPANT CONSENT FORM - INDIVIDUAL

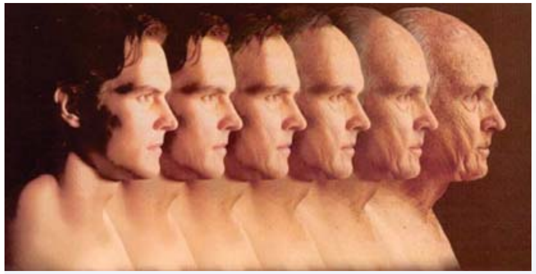
I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: .... **Date:** ....

Full Name - printed ....

Appendix L. Psychoeducational pamphlet



Changes with age

Aspects of our memory that tend to become more challenging as we age include:

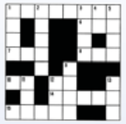
- speed of processing – we may take longer to think things through
- difficulty doing more than one thing at a time, remembering what you were doing before you were interrupted or why you went into a room
- remembering more trivial information, such as names, where you have put things, or what you wanted to buy at the supermarket

However, other mental abilities increase or remain stable with age, such as:

- vocabulary
- expertise – skills that you are very good at tend to remain more stable
- remembering things that are socially important, such as appointments or family gatherings

What can I do?

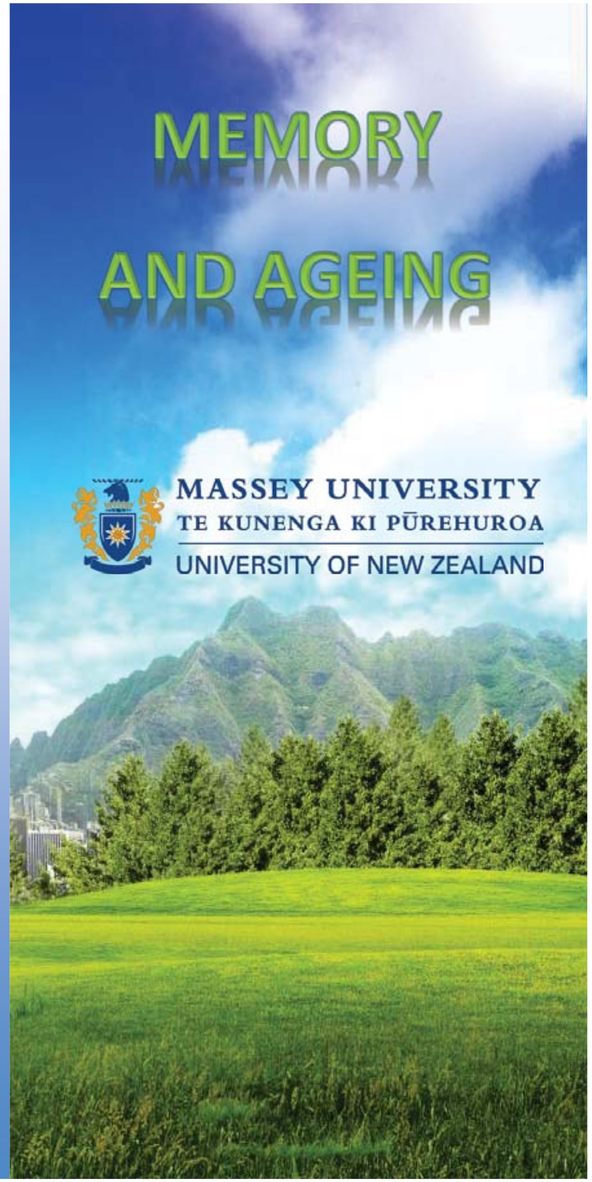
There are also many other ways that you can improve and retain your current memory abilities. These include:



- Staying mentally active – learn a new skill or practice mentally challenging tasks.

- Keeping physically healthy – eat a balanced diet, get adequate sleep, and keep up physical exercise.
- Managing your psychological well-being – seek help for depression, stress, or anxiety, and practise activities that reduce stress and bring you joy.

- Develop and maintain strong social support networks.
- Find strategies that help you compensate for any difficulties – for example, keeping a “to do” list in a prominent place, using calendars and diaries, and developing habits of putting common items in a particular place (such as your keys on a hook by the front door).



Memory Difficulties

As we get older, many people can develop concerns about their memory. While memory difficulties can be distressing, many of them are a part of normal ageing and are not indicators of dementia or Alzheimer's disease. In fact, it is common to have experienced these examples yourself.

Is it dementia?

Some people can become worried that their memory lapses signify brain diseases such as dementia. While everyday memory problems are not usually signs of brain disease, more serious memory problems that interfere significantly with daily life can be symptoms of dementia. These include:

- becoming lost in an area you know very well
- asking the same questions over and over again
- becoming confused about time – getting things from the past mixed up with the present

If you experience memory problems such as these, or if you have serious concerns about your memory, see your doctor. They can investigate the causes of any memory difficulties, and discuss possible treatment options with you.

Other causes

There are also numerous other causes of memory difficulties, and many of these can be either treated directly or compensated for by developing strategies to work around them. For example:

- sometimes memory difficulties are actually due to inattention. If we don't pay attention to information in the first place, then it is harder to recall it later. Strategies such as focusing on only one task at a time can help us better remember what we did later.
- sometimes medication has side effects which can affect your memory, and talking to your doctor about this can help resolve such issues.
- trouble concentrating can be a symptom of depression, which is treatable with medication and/or psychological therapy.
- many other medical conditions can also affect your ability to remember and recall information, and should be treated by your doctor.

Appendix M. Example testing results and feedback

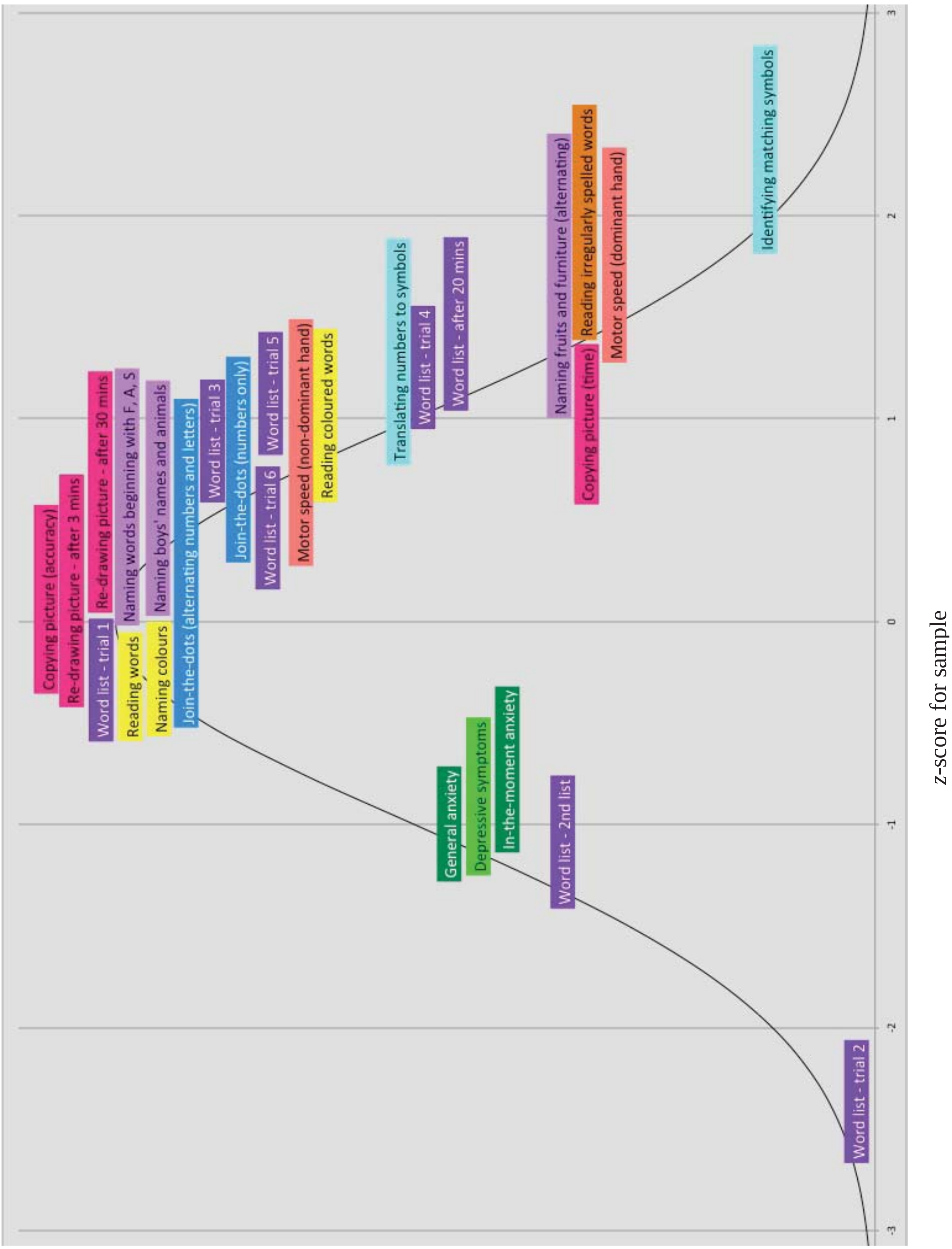


Figure N1. Example of approximate pattern of normed scores for one participant.

Example of interpretation notes

The following notes were used by the researcher to guide their discussion with a participant whose results were as displayed in Figure N1. Participants were not given direct access to these notes.

Attached is a picture of your own individual results from the testing (note that this only refers to the testing results, not the survey as well). What it shows is how your performance on each of the tests compares to other people of the same age. I know it can look overwhelming at first, but I will take you through each component.

The black curved line represents how most people perform in general – i.e., a lot of people score around the middle/average area, with fewer scoring above and below the middle on either side. Each coloured box represents where your score on one of the tests sits in relation to others your age. Different colours represent the different types of tests that we did.

Looking at the overall pattern of your scores, most of your scores are either at the same level as others your age, or better! This is shown by the clusters of boxes around the middle and right hand side of the picture.

The purple boxes represent the first test we did, where I read out a list of words and had you repeat them back to me (and then we did the same list a few times). Your scores on this are generally as good or better than what most people your age would score on this test, as you can see from the number of purple boxes that are either at the top of the bell-curve or on the right-hand side of it. Although two purple boxes are below the typical score for others your age, this is common for anyone and so is not necessarily a cause for concern. With such a large number of tests that we did, there are almost always some scores below the middle just by chance, and all it is likely to represent is the fact that we did such a large number of things in the session! Interestingly, your highest score for all these boxes was when I had you recall the words after a 20-minute delay. To me, this suggests that your memory works best when things are given some time to settle or ‘sink in’.

The green boxes represent scores on the questionnaires that you filled out – these were looking at feelings of anxiety and depression. The fact that your scores on these are lower than the middle score means that you have fewer symptoms of anxiety and depression than others your age.

The darker blue boxes represent the “join-the-dots” type test that we did – both of which you scored at least as well as most people do. Understandably your score was a little higher when the dots were a series of numbers only, rather than the harder version of the task where you had to switch between connecting numbers and letters.

The pink boxes represent the scores for copying the picture – which we did three times in total. Your scores are right in the middle every time, and show that you can do this sort of visual task just as well as anyone else. In terms of the time it initially took you to copy the picture, this was much faster than most people (and this score is further to the right hand side of the picture), which suggests that you can complete tasks more quickly than most without compromising on accuracy.

Measures of speed are also shown by the two lighter blue boxes, which represent the two tasks we did in a little booklet where you had to cross out symbols that matched, and then use a key to translate numbers into symbols. These tests can feel really odd, and the reason for that is because they are trying to get at a pure measure of how quickly your brain can work (we call this "processing speed”). Your processing speed was really good compared to others your age, well done! It was in fact your highest score, and suggests to me that your brain is capable of thinking exceptionally quickly when required. What I find most interesting about this ‘brain speed’ is how it relates to the analog in our body (“motor speed”) - this is represented by the two peachy-coloured boxes, and was measured by the task where you turned a coin around between your fingers. Your motor speed was still faster than most people your age – regardless of whether the coin was in your dominant or non-dominant hand. However, it was not quite as quick as your brain speed. Sometimes people who have quick motor speed but even quicker brain speed can find that this manifests as a habit of often thinking a few steps ahead of what they might currently be doing. I'm not sure if this would apply to you because the relative difference between these two speeds was not huge, although it might in some situations.

The yellow boxes are scores on the task where I had you read out the names of colours, and then name the colour of the ink without reading the actual word that was written. Again for this task your scores are similar to most other people your age, although interestingly your highest score was for the most difficult part of this task (the naming of ink colours that didn't match what the words actually said). My hunch is that you performed relatively better on the harder version of this task because your brain speed is so high – this task is difficult for everyone, but because you were capable of doing it faster, you could in some way compensate for the difficulty by doing it much more quickly than most other people. A similar pattern is evident for the mauve/lavender coloured boxes, which represent your scores on the final task where I had you list as many items as you can that fell into certain categories (such as animals, or words beginning with 'S'). Again you performed just as well as anyone for the simple versions of this task, but much better than most for the more difficult version (where I had you alternate between naming fruits and furniture)! I think that these results show that when a task is more difficult, it 'fits' better with your brain's naturally quick speed, and so you are able to perform really well.

Overall I think your particular results are really interesting, and show some really encouraging points about your cognitive abilities. Thank you so much for participating.

Appendix N. Parallel analysis of survey results

This appendix presents the primary findings that relate to the SMC data as presented in Chapters 5 and 7, but with distress ratings of 1 now included. A summary of how these findings relate to those in the earlier chapters is also included. All results relate to three main dependent variables: number of SMCs reported spontaneously, mean distress ratings associated with spontaneously reported SMCs, and mean distress ratings associated with questionnaire items (the fourth dependent variable present in earlier Chapters, the number of questionnaire items endorsed, is excluded here as the inclusion of all responses means that missing data represents absent rather than excluded responses).

Chapter 5 Results

Preliminary Analyses

Independent samples t-tests showed that as in the original analyses, participants of Pākehā/New Zealand European descent did not differ significantly from participants of other ethnicities on the number of SMCs reported spontaneously (p = .848), the distress ratings assigned to SMCs reported spontaneously (p = .820), or distress ratings for items endorsed on the questionnaire (p = .527).

Similarly, there were no significant differences between participants who completed the survey online and those who completed hard copies, either on distress ratings assigned to spontaneous reports (p = .072) or questionnaire items (p = .238). However, as in the original findings, participants who completed the survey online (M = 2.80, SD = 1.45) did spontaneously report significantly more SMCs (t(51.14) = 3.69, p = .001) than those who completed hard copies of the survey (M = 2.11, SD = 1.05).

Middle-aged adults (ages 40-64; M = 3.56, SD = 1.24) assigned significantly higher distress ratings to their spontaneously reported SMCs (t(401) = 2.72, p = .007) than older adults (aged 65 and above) did (M = 3.21, SD = 1.17). The same pattern was evident on the questionnaire items (t(419) = 3.14, p = .002), with middle-aged adults (M = 2.46, SD = .89) rating the items they endorsed as more distressing than older adults did (*M* = 2.19, *SD* = .73). There was no significant difference in the number of SMCs reported spontaneously between the groups (p = .072).

In addition, there were no significant differences on the basis of gender for any of the SMC variables (when both including and excluding distress ratings of “1”; p = .232 - .838).

Comparison of Assessment Methods

As in the original analysis, paired samples t-tests revealed that participants reported significantly fewer complaints ($t(400) = 180.42$, $p < .001$, $d = 12.52$) under spontaneous report (*M* = 2.74, *SD* = 1.43) than questionnaire methods (*M* = 23.51, *SD* = 1.86), but that they assigned significantly higher distress ratings ($t(402) = 20.59$, $p < .001$, $d = .99$) to their spontaneously reported difficulties (*M* = 3.44, *SD* = 1.23) than to the questionnaire items (*M* = 2.40, *SD* = .84) overall.

Chapter 7 Results

Descriptive statistics for the participants’ scores on the SMC variables are shown in Table O1.

Table N1. Test Score Descriptive Statistics (*z*-scores for sample)

Construct	Measure	*n*	Minimum	Maximum	Mean	Standard deviation
SMCs	Number of spontaneously reported SMCs	90	1	7	2.83	1.52
	Distress associated with spontaneously reported SMCs	91	1	6	3.50	1.07
	Number of SMC questionnaire items endorsed	94	9	24	23.42	2.17
	Distress associated with endorsed SMC questionnaire items	94	1.14	4.75	2.43	.86

Note. SMC = subjective memory complaint.

Univariate Results

Independent samples t-tests and one-way analyses of variance were used to analyse the effect of demographic and other participant variables on SMC measures. As in the original analysis, the only significant effect of gender was that females (*M* = 3.14, *SD* = 1.47) spontaneously reported more SMCs than males (*M* = 2.30, *SD* = 1.53; *t*(88) = 2.57, *p* = .012, *d* = .56). There were again no significant effects of age, education, ethnicity or working hours on any of the SMC variables, nor were there significant differences in SMCs between participants who had seen a doctor regarding their memory and those who had not, or between those who reported neurological history of any kind and those with none.

Correlations between the subjective memory, cognitive, and psychological variables are shown in Table O2. Of the SMC variables, the distress associated with questionnaire items was most often related to other variables, being significantly correlated with both processing speed measures, two executive functioning measures (scores on the Stroop interference trial and Verbal Fluency switching trial), and depressive symptoms. Distress ratings for spontaneously reported SMCs were also associated with depressive symptoms. The number of spontaneously reported SMCs was associated with scores on the RAVLT Trial B (as in the original analysis).

Table N2. Test Score Correlations

Construct	Measure	Number of spontaneously reported SMCs	Distress associated with spontaneously reported SMCs	Distress associated with SMC questionnaire items
Processing speed	Coding	.02	-.04	-.22*
	Symbol Search	.05	.00	-.30**
	Stroop (word reading)	.07	.03	-.10
	Stroop (colour naming)	.12	.04	-.10
	Stroop (interference trial)	.03	.00	-.25*
	TMT – A	.12	.07	-.05
	TMT – B	.02	.03	-.13

Construct	Measure	Number of spontaneously reported SMCs	Distress associated with spontaneously reported SMCs	Distress associated with SMC questionnaire items
	Verbal fluency (letters)	.16	-.07	-.12
	Verbal fluency (categories)	.09	.00	-.14
	Verbal fluency (switching)	-.05	-.12	-.23*
Memory	RAVLT Trials 1-5	.20	.01	-.02
	RAVLT Trial B	.26*	.05	.06
	RAVLT Trial 6	-.03	-.03	-.17
	RAVLT Trial 7	.01	-.03	-.14
	RCFT immediate recall	-.11	.01	-.15
	RCFT delayed recall	-.07	.01	-.09
Depressive Symptoms	BDI – II	.20	.38**	.39**
Anxiety symptoms	STAI – State	-.11	.08	.11
	STAI – Trait	.13	.20	.15
Other covariates	Mood	.05	.20	.09
	Stress	.04	.04	.02
	Social support	-.06	.01	.17
	Physical health	.06	.13	.10
	Exercise	-.08	.04	.00
	Motor speed – dominant hand	.02	.03	-.03
	Motor speed – non-dominant hand	-.05	.03	-.06
	Premorbid intelligence	.01	-.10	-.14

* = p < .05.
** = p < .01.
Note. SMC = subjective memory complaint; TMT = Trail Making Test; RAVLT = Rey Auditory Verbal Learning Test; RCFT = Rey Complex Figure Test; STAI = State-Trait Anxiety Inventory.

Multivariate Results

A moderation analysis was conducted using multiple regression. First, an index of processing speed was calculated using the procedure for combining Coding and Symbol Search scores given in Wechsler (2008) in order to prevent substantial collinearity. Similarly, an index of executive function was calculated by averaging the scores on the Stroop interference and Verbal Fluency switching trials. Then, scores on the three predictor variables (processing speed index, executive function index, and BDI-II) were centred, and two interaction terms (between depressive symptoms and both the centred processing speed index and centred executive function index scores) were created.

The following assumptions of multiple regression were met (using criteria from Tabachnick & Fidell, 2013). The ratio of cases to independent variables exceeded the recommended $N \geq 50 + 8m$, with $N = 94$ participants and $m = 5$ predictor variables. The dependent variable did not demonstrate significant kurtosis ($p = .429$) but was significantly positively skewed ($p = .003$) and so the dependent variable was logarithmically transformed to approximate a normal distribution. Inspection of bivariate scatterplots showed no evidence of non-linearity. There were no univariate outliers ($z \geq \pm 3$SD) for any of the dependent or predictor variables. A regression analysis using the three non-interaction term predictors (i.e., processing speed, Stroop interference trial score, and depressive symptoms) showed no multivariate outliers (Mahalanobis distances exceeding $\chi^2(3) = 16.27$, $p < .001$).

The three predictor variables and two interaction terms were entered into a regression with the distress associated with questionnaire items endorsed as the dependent variable (as this was the only SMC measure that correlated significantly with processing speed and executive function measures). The overall model was significant ($R^2 = .481$, $F(5, 86) = 5.17$, $p < .001$, $f^2 = .928$). There was a significant main effect of depressive symptoms on the number of SMC questionnaire items endorsed ($\beta = .36$, $t = 3.64$, $p < .001$), whereby more depressive symptoms were associated with greater SMC distress ratings. There were no significant main effects of processing speed ($p = .195$), executive function ($p = .319$), the interaction of processing speed and depressive symptoms ($p = .935$), or the interaction of executive function and depressive symptoms ($p = .150$).

Summary

Where the primary analyses presented in this thesis excluded SMCs which participants rated as "not at all a problem", this parallel analysis of survey results included such ratings in order to determine whether this exclusion affected the conclusions drawn.

Regarding the reports of SMCs under different assessment methods (Chapter 5), conclusions were consistent with the earlier findings. Participants spontaneously reported fewer SMCs than they endorsed on the questionnaire, but they rated their spontaneously reported SMCs as more distressing than the questionnaire items overall. These findings are not surprising given that the number of questionnaire items endorsed was 24 (i.e., the full number of questionnaire items) unless participants had omitted any items.

Findings for the relationship of SMC variables to cognitive and psychological variables did however differ somewhat from the original analysis. Chapter 7 reports that cognitive and psychological variables were related to the number of questionnaire items endorsed. Specifically, depressive symptoms were positively related to the number of questionnaire items endorsed, and for participants with relatively high levels of depressive symptoms, processing speed was also negatively related to the number of questionnaire items endorsed. In the current parallel analysis however (which included non-distressing SMCs), the number of questionnaire items endorsed lost any practical meaning because any non-endorsed items merely represented missing data rather than SMCs that were not experienced. Instead, cognitive and psychological variables were related to the distress associated with the questionnaire items. While processing speed and executive function measures were also negatively related to the distress associated with questionnaire item SMCs, regression analysis showed that the only significant predictor of this distress was in fact depressive symptoms.

This finding highlights the robust relationship between depressive symptoms on SMCs, reinforcing earlier assertions that depressive symptoms have the most significant effect on SMCs. One explanation for the lack of any significant relationships between SMCs and any other variables in this analysis is that they were obscured by the floor effects present when ratings of “1” were included. Another possibility is that the different dependent variables reflect different aetiologies. For example, the number of SMCs endorsed may be related to both affective and cognitive variables (as in the original analysis), whereas the distress associated with SMCs is primarily related to affect only (as in this parallel analysis).

Overall, findings from the parallel analyses presented here are consistent with the findings and interpretations offered earlier, but offer less practical relevance due to the inclusion (and potential dominance) of SMCs which participants rated as “not at all a problem”.

Appendix O. Poster presented at conference