Subjective Cognitive Decline: Exploring Neuropsychological Testing, Personal Perspectives and Affective Factors on Cognitive Function Overtime.

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Thesis Portfolio Abstract

Subjective cognitive decline (SCD) involves self-perceived cognitive deterioration and may represent an early stage of mild cognitive impairment (MCI). This thesis presents three papers examining mood-related risks; longitudinal change using online neuropsychological testing; and lived experiences of SCD.

This portfolio introduces current knowledge of SCD, outlining research gaps, leading to a systematic review on SCD in older adults, with mood as longitudinal risk factors. Depression was found to increase the risk of developing MCI or Alzheimer's Disease (HR = 1.45, 95% C.I. [1.25, 1.68], p <.001). However, findings are impacted by fewer longitudinal studies focusing on older adults with depression and anxiety as predictors.

While the review explored SCD longitudinally, it did not focus on online neuropsychological testing. This thesis presents a study with older adults who completed online testing in 2023, with reassessment six-months later and then again 2025. This study aimed to identify whether SCD progressed into MCI in a two-year period, and the utility of online testing. Participants also completed the Verbal Associative Learning Memory Test (VALMT). No participants reported having MCI, though all reported SCD. Testing scores remained unchanged across timepoints, possibly reflecting stability in SCD presentation, or indicate online tests lacked sensitivity. VALMT scores showed a significant reduction in learned word-pairs after 55-minutes and 24-hours.

Additionally, this portfolio explored personal experiences of living with SCD, identifying four themes. Participants described attentional, multi-tasking and word-finding difficulties, and cited these as “memory” decline, indicating this is how they interpreted living with SCD.

This portfolio supports the view that SCD may reflect an early stage in the cognitive decline trajectory. Findings of the SR highlight older adults with SCD, and depression may be at increased risk of further cognitive decline over time. Findings of the quantitative empirical paper highlight that SCD may remain stable for several years, particularly when examined via online testing. This highlights areas for future research regarding practicality and sensitivity of online neuropsychological

testing. Furthermore, the qualitative study indicates how people with SCD articulate their cognitive concerns. They may cite memory difficulties, while describing attentional, working memory, multi-tasking and word-finding difficulties alongside physical health decline. These findings have implications for the assessment and management of people presenting with SCD, alongside affective symptoms.

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This thesis portfolio is dedicated to the memory of my grandparents, Phillip and Betty Leventhall, and Grandad Michael Togher.

Declaration

Content from the ClinPsyD Thesis Proposal assignment has been used throughout this portfolio.

CHAPTER ONE: Introduction to the Thesis Portfolio

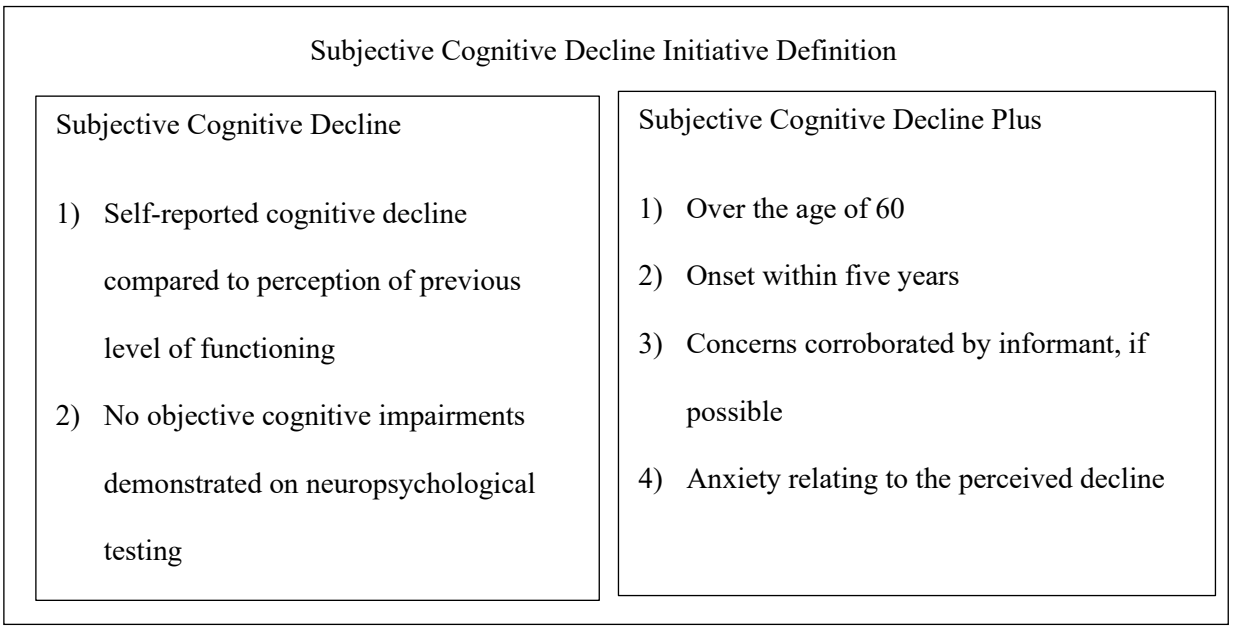
General Introduction

The UK has an ageing population (Office for National Statistics [ONS], 2021), with cases of dementia expected to increase. Wittenberg et al. (2019) suggest that average healthcare costs for dementia in the UK will increase from £5,440 in 2015 per person to £7,630 by 2040, with total annual healthcare costs rising from £3,530m in 2015 per person to £10,310m over the same period. Therefore, there has been increased awareness on the earlier detection of dementia.

Subjective cognitive decline (SCD) is a relatively new concept. In 2014, a group of researchers and clinicians formed the SCD-Initiative (SCD-I). This was a working group to develop a standardised terminology and criteria to define SCD in research. From this, SCD was defined as an individual's self-reports of persistent changes to their cognitive function, without objective deterioration demonstrated on neuropsychological testing (Jessen et al., 2014; 2021). Furthermore, the National Institute on Aging and Alzheimer's Association (NIA-AA; Jack et al., 2018) characterises SCD, in combination with Alzheimer's disease (AD) biomarkers, as a potential early presentation within an AD continuum. During this stage, individuals may experience subtle cognitive changes but otherwise not be considered to have an objective cognitive impairment. Figures 1 and 2 present a visual representation of these frameworks. However, as this thesis portfolio focuses more on neuropsychological testing performance, rather than biomarkers, the SCD-I (Jessen et al., 2014) definition is referred to throughout.

Figure 1

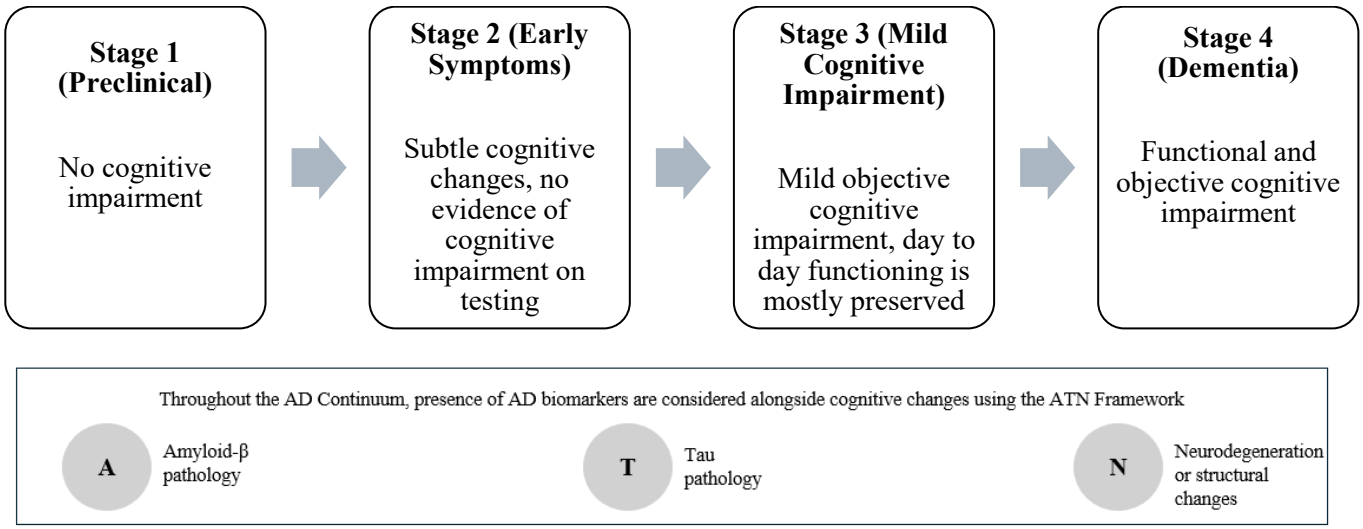
Conceptualisations of SCD using the SCD-I (Jessen et al., 2014) definition



Note: SCD Plus features do not need to be present to fulfil the criteria of SCD within this framework, but may represent a subgroup of individuals within this definition

Figure 2

Conceptualisations of SCD using the NIA-AA (Jack et al., 2018) AD continuum framework



Note: While this definition does not use the term SCD, Stage 2 would be considered SCD within the SCD-I definition

While SCD is not considered a clinical diagnosis, literature indicates that self-reported cognitive decline may be associated with increased risk of developing mild cognitive impairment (MCI) and dementia (Pike et al., 2022; Van Harten et al., 2018). Furthermore, a study exploring neuropsychological test scores within SCD and progression identified neuropsychological process scores, which examine patterns of encoding, learning slopes and error patterns, may be more efficient for identifying individuals with SCD at increased risk of developing MCI (Thomas et al., 2018).

Additionally, research has focused on risk factors associated with SCD, in which older age, thyroid disease, presence of subclinical anxiety symptoms and daytime dysfunction (feeling too fatigued to complete tasks) were identified as consistent risk factors (Wen et al., 2021). Furthermore, low levels of anxiety and depression have been identified to be associated with SCD (Hill et al., 2016; Jessen et al., 2020). Therefore, older adults reporting SCD, alongside mood related symptoms may represent an at-risk group for further cognitive decline and would benefit from longitudinal monitoring.

Use of Online Neuropsychological Testing for Assessing and Monitoring SCD

As mentioned above, the predicted healthcare costs for dementia are expected to increase substantially by 2040. Therefore, offering funding and resources for longitudinal follow-up presents a challenge to the NHS. Furthermore, older adults are more likely to miss appointments (Parsons et al., 2021). This age group faces more barriers with accessing medical appointments, such as remembering appointment dates (Sung et al., 2024) and socio-economic and geographic barriers (Cabañero-Garcia et al., 2025). Therefore, offering online, remote alternatives that can be undertaken at home may present as a viable option.

The NHS long-term plan (NHS England, 2019) outlined strategies for developing and delivering dementia therapies via the Dementia Goals Programme. Additionally, the long-term plan focused on moving towards more remote, online resources for developing appointments. While this has raised criticism relating to digital exclusion, particularly of older populations (Age UK, 2024), internet and technology use has risen amongst older groups, particularly following the Covid-19

Pandemic (King & Steptoe, 2023). While the use of online neuropsychological testing platforms are not routinely used for monitoring SCD in the NHS at present, this thesis presents a study in which older adults with SCD undertook repeated neuropsychological testing over a two-year period.

Aims of the Thesis

The overall aim of this thesis portfolio is to further the understanding of SCD in older adults, focusing on the role of anxiety and depression and lived experience, as well as examining longitudinal cognitive change using online neuropsychological testing. These aims are addressed by the following:

- A systematic review and meta-analysis, focusing on the potential association between SCD and symptoms of depression or anxiety and risk of further cognitive decline. The review specifically focuses on older adult populations, rather than a combination of middle-aged and older cohorts typically recruited in SCD research.
- A quantitative empirical paper involving a cohort of older adults, aged 60 and over, who undertook online neuropsychological testing as part of Peterson et al, (2025) study. As part of this study, participants a battery of memory and concentration-based tests in 2023, which were repeated six months later to examine for test re-test reliability. Participants who consented to be contacted regarding future research and participated in Peterson et al. (2025) were invited to complete the same tests as part of the present research. These were examined for change over two-years. Additionally, participants were invited to complete a novel word-pair designed to assess encoding, consolidation and retention.
- A qualitative empirical paper to understand the personal experiences of SCD from interviews with individuals with self-reported cognitive decline. This was to identify key areas people with SCD notice changes, the impact this has on them, and how they manage.

Together, these studies provide a deeper understanding of the progression of SCD over a two-year period, along with an exploration of how individuals report self-perceived cognitive decline. Thus, highlighting specific cognitive concerns individuals with SCD notice, alongside their

performance on neuropsychological tests. Collectively, these papers help better understand SCD, its impact on individuals and inform future clinical practice.

CHAPTER TWO: Systematic Review

A systematic review and meta-analysis of the relationship between depression and anxiety on Subjective Cognitive Decline in older adults.

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Abstract

This systematic review and meta-analysis (PROSPERO ID: CRD420251054485) aimed to examine whether depression and anxiety in older adults with subjective cognitive decline (SCD) increases the risk of further cognitive decline longitudinally. A systematic search was conducted (PsychINFO, Web of Science, SCOPUS and PubMed) in December 2025. Longitudinal studies with an SCD cohort, anxiety and depression measured as predictor factors from 2014 onwards were included. Seven studies met inclusion criteria, three of which were included in a random-effects meta-analysis (SCD at baseline N=5,152). All papers were synthesised narratively. Risk of bias was completed using the Newcastle-Ottawa Scale for cohort research. Results of the meta-analysis indicated that depression increased risk of further cognitive decline in older adults with SCD (HR = 1.45, 95% C.I. [1.25, 1.68], p <.001). Results of the narrative synthesis support the findings of the meta-analysis, with anxiety appearing to have a less clearly defined relationship in SCD and longitudinal decline. These results suggest that when assessing older adults reporting SCD, depressive symptoms should be considered as part of earlier detection for further decline, with follow-ups and future monitoring for progression.

Introduction

Adults aged 65 or older represent one of the fastest growing age groups in the UK (Office for National Statistics [ONS], 2021). Dementia prevalence rates within over 65s are estimated at one in 14, increasing to one in six in the over 80s (Stevenson-Hoare et al., 2023). Diagnoses are predicted to rise alongside the aging population, posing increasing demands to health and social care services (Chem et al., 2023; Wittenberg et al., 2019). Therefore, there is growing emphasis on earlier detection of dementia and identifying risk factors.

Dementia encompasses several neurocognitive illnesses, of which Alzheimer's Disease (AD) is the most prevalent (Liang et al., 2021). The National Institute on Aging-Alzheimer's Association (NIA-AA) framework conceptualises AD as a continuum, in which neuropathological changes may present years before cognitive symptoms (Jack et al., 2018). The framework outlines three stages, (1) Cognitively unimpaired, whereby an individual's cognition remains unchanged, though they may self-report changes to cognitive skills. (2) Mild cognitive impairment (MCI), in which an individual demonstrates cognitive deterioration but is still able to function independently (3) Dementia, in which an individual demonstrates significant decline on cognitive testing and functioning.

Subjective cognitive decline (SCD) pertains to individuals who perceive deterioration to their cognition, most notably memory, with no objective impairment on neuropsychological testing (Jessen et al., 2014). While MCI may increase risk of AD, similarly, SCD may be associated with developing MCI, particularly in individuals with AD biomarkers (Harten et al., 2012; Rostamzadeh et al., 2022).

Perceived SCD is one risk factor for further cognitive decline. Depression in later life has been associated with increased risk of developing AD even if treated with anti-depressant medication (Linnemann & Lang, 2020). Furthermore, AD and depression may share features that increase susceptibility to further structural changes and cognitive decline, such as increased neuroinflammation, cerebrovascular changes and neurodegeneration (Weisenbach et al., 2019). Similarly, anxiety in older adults with MCI is linked to faster cognitive decline (Cai et al., 2021; Mah et al., 2015; Pietrzak et al., 2015).

Anxiety and depression have been found to co-occur in individuals with SCD (Balash at al., 2012; Brown et al, 2020). However, literature suggests affective factors exacerbate perceived cognitive complaints, rather than present as a risk factor for further decline (Fernández-Blázquez et al., 2016; Hill et al., 2016). Emerging evidence in longitudinal studies with middle-aged cohorts with SCD suggest these symptoms increase risk of conversion to MCI (Liew et al., 2019; Liew et al., 2021).

Research into SCD has tended to include middle and older-aged participants, possibly due to 10 – 20% of middle-aged adults reporting cognitive concerns (Roh et al., 2021; So et al., 2024). Additionally, studies tend to employ a cross-sectional design, focusing on anxiety and depression as covariates, rather than predictors. Therefore, understanding whether anxiety and depression in SCD increase risk of progression to objective cognitive decline over time is less researched.

This review aims to address this gap by focusing on longitudinal research with older adults aged over 60 (World Health Organisation [WHO], 2002). SCD will be defined by the SCD-Initiative (Jessen et al., 2014) or NIA-AA criteria (Jack et al., 2018). Furthermore, this review aims to gain further understanding as to whether anxiety and depression increase risk of developing objective cognitive decline in older adults with SCD.

Methods

Study Registration

The study was registered on the International Prospective Register of Systematic Reviews (PROSPERO ID: CRD420251054485) on 28 May 2025. The updated guidelines for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021) were followed throughout.

Search Strategies

Systematic literature searches were completed in December 2025. This identified longitudinal studies examining the relationship between anxiety and/or depression and SCD in older adults. Searches were designed to identify studies involving participants with SCD, who completed standardised neuropsychological assessment and valid mood measures, with follow-up to examine for further decline.

Databases searched were PubMed, Scopus, PsycINFO and Web of Science. Searches were restricted to peer-reviewed articles. A separate grey literature search was not conducted as part of the search strategy. However, PsycINFO includes some grey literature (Aromotaris et al., 2024).

Seah terms were subjective cognitive decline OR SCD OR subjective memory complaint AND depression or depressive disorder or depressive symptoms or major depressive disorder OR anxiety disorders or anxiety or generalized anxiety disorder AND older adults or elderly or geriatric or geriatrics or aging or senior or seniors or older people or aged 60+ AND follow up or follow-up OR longitudinal. MeSH terms were utilised for PubMed.

A full summary of eligibility criteria and search strategy can be found in Appendix A.

Study Selection

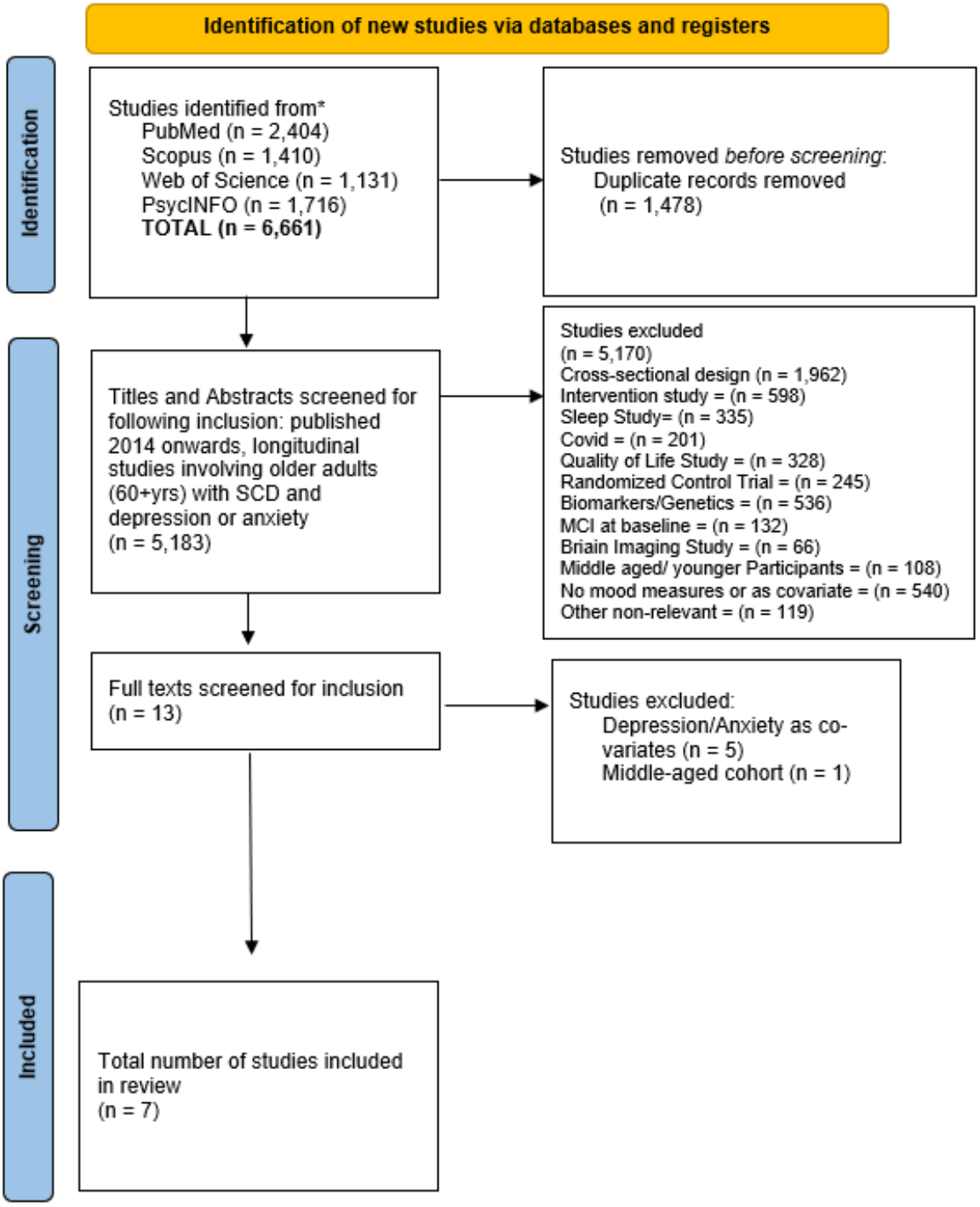
The following inclusion criteria was operationalised to determine which papers met eligibility: (1) peer-reviewed journal post 2014, following the operationalisation of SCD in research literature by the SCD-Initiative (Jessen et al. 2014), (2) included participants with SCD assessed at baseline and follow-up , (3) participants were ≥60 years at baseline, to ensure study populations were exclusively older adults, rather than a combination of middle-aged and young participants, (4) standardised mood measures completed with mood included as a predictor. (5) recruitment from community or clinical settings. Exclusion criteria included studies focusing on SCD within the context of other illness, or where mood was used as a covariate. Furthermore, much of the literature into SCD employs a cross-sectional design, therefore now allowing for longitudinal observation.

Therefore, studies applying non-longitudinal designs (e.g. case studies, cross-sectional) were excluded,

Lead researcher RL, and second-rater JH independently reviewed the papers for eligibility. RL screened all titles and abstracts (n = 5,183) and JH completed f 20% (n = 1,022) as per Cochrane guidance (Higgins et al., 2020). Following screening titles and abstracts, RL and JH screened full texts separately (n = 13), which identified seven papers for data extraction. Disagreements were discussed between raters, and both completed the Newcastle-Ottawa risk of bias rating independently. Agreement during the title and abstract, along with full text, screening processes was high with a a Cohen's kappa =.90. for both stages,

Figure 1

PRISMA flow chart for the review



Data Extraction

Key data was independently extracted from the papers meeting inclusion criteria by the two reviewers (RL and JH) and shown in Table 1. Methods for how the studies defined SCD and measured anxiety and depression are shown in Table 2. Additionally, data for the meta-analysis was also extracted separately including the effect type, effect size value, confidence intervals (95% CI), standard error (SE) and variance.

Data Synthesis and Analysis

All papers were analysed using narrative synthesis applying the four stages outlined in Popay et al. (2006). These include developing an initial theory, a preliminary synthesis, exploration of relationships between and within studies and assessment of the robustness of synthesis. Typically, this approach is applied for reviews examining interventions. However, the method was adapted for this review by focusing on cognitive decline as the outcome, rather than intervention effects.

The first stage of the Popay (2006) approach cites the development of an initial theory. The potential association between depression in later life and increased risk of developing dementia has been explored in previous literature (Linnenmann & Lang, 2020; Weisenback et al., 2019). Anxiety has also been suggested to be associated with faster decline in older adults with MCI (Cai et al., 2021; Mah et al., 2015). Furthermore, anxiety and depression within middle-aged adults may be associated with conversion to MCI over time (Liew et al., 2019; 2021).

Therefore, the initial theory guiding this review was the possible association between depression or anxiety in older adults with SCD and the potential increased risk of further cognitive decline, as evidenced by poorer performance on neuropsychological testing or obtaining a diagnosis of MCI or dementia.

An initial, preliminary synthesis was undertaken to group findings across the studies using tabulation and summaries of key findings. Studies were grouped based on sample, definitions and

measures applied for SCD, mood measures, length of follow-up, and findings. Synthesis focused on similarities and differences between the studies, as well as robustness of findings overall.

Three of the papers provided a consistent effect-size (hazard ratios). Therefore, it was decided to complete and additional meta-analysis. These papers examined the time-to-event progression between SCD and depression and further cognitive decline, with participants obtaining a diagnosis of MCI or dementia, in keeping with the methods described by Tierney et al. (2007), HRs were transformed into natural logarithm (lnHR), with SE and variance being calculated from confidence intervals.

A random-effects meta-analysis was used, as this model accounts for variances in true effect sizes and heterogeneity between studies (Borenstein et al., 2009). Data analysis was completed using the "Metafor" package (Viechtbauer, 2010) within R (version 4.5.2) and RStudio (version 2026.1.0.392) (R Core Team, 2024).

Study Quality

The Newcastle-Ottawa scale (NOS, Wells et al., 2009) for cohort studies was used to assess the risk of bias. This was selected as it can be applied to longitudinal studies and has specific considerations around follow-up. The NOS consists of three main domains: selection, compatibility and outcome, each with subdomains. The lead researcher and second-rater completed the NOS independently. Inter-rater reliability was high (weighted kappa = .81).

Results

Seven studies were included in this review and synthesised narratively. Three studies provided HRs and were compatible for meta-analysis. Kleineidam et al. (2022) presented two studies in one article, each with separate study cohorts, methods and analysis. Both of which were included in

this review. Studies included in the meta-analysis were Kleineidam et al. (2022a); Donovan et al. (2014) and Ahn et al. (2020).

Two papers (Ahn et al., 2021a; Ahn et al., 2021b) were published separately. However, the findings were obtained from one study cohort, with each paper focusing on different cognitive domains. Both papers were included in the narrative synthesis, with findings synthesised together owing to the overlapping sample. They were distinguished separately in the extracted data to reflect the fact they were separate publications. These papers reported linear mixed-effects regression coefficients for continuous cognitive outcomes, which could not be combined with the HRs into a compatible effect size for the meta-analysis (Higgins et al., 2024).

Table 1

The characteristics of studies included in this review

Study	N	N-SCD Group at baseline	Age M (SD)	Sex (%F)	Education years M (SD)	Predictor	Length of Follow-up	Findings	N Progressors/Non Progressors	Neuropsychological Tests Used	Definition of cognitive decline
Kleineidam et al., (2022)a*	Baseline 3,217 (SCD at baseline N = 1,876) Follow-up 2, 593 (SCD at baseline N = 1,508)	N-SCD at baseline group Baseline N = 1,341 Follow-Up N = 1,085	77.9 (3.59)	65.5	Not reported	Depression	12 years	Higher depression symptoms at baseline and/or increasing symptoms at follow-up associated with increased risk of decline in SCD HR = 1.45, 95% CI = 1.19 – 1.77	748 (Dementia) 511 (“Dementia Alzheimer’s Type”) Non-Progressors not reported	CERAD delayed word list recall	DSM-IV; (APA, 1994) for dementia NINCDS-ADRDA criteria for AD (McKhann et al., 2011)
Ahn et al., (2020)*	Baseline 3,211 Follow-up 1,525	No	73.8 (8.1)	67.1	15.9 (2.8)	Depression and anxiety	M = 4.7 (2.9) years	Depression: symptoms predicted progression HR = 1.36, 95% CI [1.03–1.79], p = .028 Anxiety: non-significant	335 aMCI 51 AD 1,139 Non-Progressors	MMSE; CDR	MCI: Single or multi domain aMCI - Petersen et al (2004) criteria; AD: NIA-AA (McKhann et al., 1984) NINCDS-ADRDA criteria for AD

											(McKhann et al., 2011)
Donovan et al., (2014)*	Baseline 559 (SCC** n = 65) Follow-up 454 (SCC n = 56)	Yes Cognitively Normal [CN] Baseline N = 388 Follow-Up N = 283 MCI Baseline N = 156 Follow-Up N = 115	72.5 (9.6)	64.6	16.2 (2.6)	Depression and anxiety	M = 2.43 (1.0)	Depression significantly increased risk of decline HR = 1.6, 95% CI = 1.11 – 2.31 Anxiety: non-significant	SCC to MCI: 16 SCC to probable AD: 1 CN to SCC: 41 CN to MCIL 22 MCI to probable AD: 36 MCI to Dementia (unspecified): 8 Non-Progressors not reported	MMSE; CDR; UDS neuropsychological battery [WMS Logical Memory immediate I and delayed recall II; Category fluency; BNT; DSF; DSB; TMTA, TMTB, Digit Symbol)	Clinical interview with trained clinician
Raymond-Lessard et al., (2025)	Baseline 140 Follow-up 80	No	71.71 (5.11)	72.5	15.07 (3.67)	Depression and anxiety	4 years	Hopeless subscale on depression measure was significantly high in SCD-Progressors	21 (“Objective cognitive decline”) 29 Non Progressors	MoCA; WMS-III Logical Memory II; CDR	NIA-AA criteria for MCI or probable AD (McKhann et al., 1984)

								than SCD-Non progressors No significant differences between SCD-P and SCD-NP on anxiety scale			
Kleineidam et al., (2022)b	Baseline 334 Follow-up 254	No	66.5 (8.72)	40.7	12.64 (3.00)	Depression	4 years	Persistent or increasing depression symptoms significantly associated with cognitive decline	31 (Dementia) 22 ("Dementia Alzheimer's Type") Non-Progressors not reported	ADAS-Cog 11; mPACC5	Deterioration in test performance
Ahn et al., (2021)a	Baseline 1,401 Follow-up 1,401***	No	74.0 (8.2)	67.5	15.9 (2.8)	Depression and anxiety	1 – 9 years (M = 4.1, SD = 2.4)	Depression alone: significantly associated with episodic memory and executive function decline over time. Anxiety alone: no significant relationship	Not reported	Immediate and delayed recall tests from WMS-R; DSB; Category Fluency; BNT; TMTA; TMTB; Digit symbol (WMS-R)	Cognitive decline assessed by repeated cognitive assessment

								Depression and anxiety: significantly associated in attention decline over time.			
Ahn et al., (2021)b	Baseline 1,401 Follow-up 1,401***	No	74.0 (8.2)	67.5	15.9 (2.8)	Depression	1 – 9 years (M = 4.1, SD = 2.4)	Depressive symptoms predicted episodic memory decline	Not reported	Immediate and delayed recall tests from WMS-R	Cognitive decline assessed by repeated cognitive assessment

Note: * Used in meta-analysis*;* ** Defined SCD as Subjective Cognitive Complaint (SCC); ***Longitudinal retrospective study design and therefore only participants with adequate follow-up data from available database included in analyses

CDR = Clinical Dementia Rating scale (Berg, 1984; Hughes et al., 1982), WMS-III/WMS-R = Weschler Memory Scale v3 or Revised (Weschler, 1987; Weschler, 1997), MoCA = Montreal Cognitive Assessment (Nasreddine et al., 2005), MMSE = Mini Mental State Exam (Folstein et al., 1975), CERAD = Consortium to Establish a Registry for Alzheimer's Disease (Schmid et al., 2014), ADAS-Cog 11 = Alzheimer's Disease Assessment Scale-Cognitive Subscale (Rosen et al., 1984), mPACC5 = Modified Preclinical Alzheimer's Cognitive Composite 5, (Papp et al., 2017), DSB = Digit Span Backwards (Weschler, 1981), BNT = Boston Naming Test (Goodglass & Kaplan, 1983), TMTA and TMTB = Trail Making Test A; Trail Making Test B (Reitan, 1958) , UDS = The Uniform Data Set (Morris et al., 2006).

Table 2

Criteria for defining SCD, depression or anxiety and cognitive decline across the studies included in this review

Study	Definition of SCD	Definition of Anxiety/Depression
Raymond-Lessard et al., (2025)	Elements of the Jessen et al., (2014) SCD-Initiative criteria: Participants endorsed self-reported memory decline with or without further concerns, without objective cognitive impairment. The authors also operationalised SCD via (1) Telephone screening using the Mini Mental State Exam (MMSE); (2) Normal baseline scores on the Clinical Dementia Rating scale (CDR), Montreal Cognitive Assessment (MoCA), and Logical Memory II subtest from Wechsler Memory Scale third edition (WMS-III).	Self-report (GDS-30, Yesavage et al., 1982). Symptoms were explored using six dimensions of this measure: dysphoric depressive symptoms, withdrawal, worry-anxiety, cognitive decline, hopelessness and agitation. Endorsement of ≥3 items was used to indicate presence of depressive symptoms. Geriatric Anxiety Inventory (GAI-20, Pachana et al., 2006). Symptoms were explored using three dimensions of this measure: cognitive anxiety, somatic anxiety and arousal. Endorsement of ≥2 items was used to indicate presence of anxiety symptoms.
Kleineidam et al., (2022)a	Not explicitly stated, though aspects of the Jessen et al., (2014) SCD-Initiative Criteria: Participant self-report of cognitive decline with or without further concerns. Additionally, the authors operationalised SCD by; (1) using the Consortium to Establish a Registry of Alzheimer's Diseases (CERAD, Schmid et al., 2014) delayed list recall test to assess performance alongside self-reported memory; (2) GP opinion confirming absence of dementia.	Self-report Geriatric Depression Scale (GDS-15; Yesavage & Sheikh, 1986). Authors modified measure to remove question relating to cognitive concerns. Presence of depressive symptoms not determined by cut-off score, rather a median split to create definitions of "low" versus "high" depressive symptoms at baseline. Follow-up mGDS-15 defined symptoms as "persistently low", "decreasing" "persistently high" or "increasing".
Kleineidam et al., (2022)b	(1) Self-reported cognitive complaints without objective cognitive decline (2) No evidence of MCI as per the Jak-Bondi criteria (Bondi et al., 2014) (3) Completion of nine cognitive tests, with at least one deviant test result (-1 SD).	Interview based Montgomery-Abserg Depression Rating Scale (MADRS; Montgomery & Åsberg, 1979). No cut-off scores were applied, rather a median split to create definitions of "low" versus "high" depressive symptoms as baseline. Follow- up MADRS defined symptoms as "persistently low", "decreasing" "persistently high" or "increasing".
Ahn et al., (2021)a Ahn et al., (2021)b	(1) Clinical, semi-structured interview involving self-reported memory decline (2) no evidence of objective decline indicated by score of 27+ Mini Mental State Exam (MMSE) and score of 0 on Clinical Dementia Rating (CDR) scale.	Clinician administered and informant based Neuropsychiatric Inventory Questionnaire (NPI-Q; Kaufer et al., 2000) on symptoms over the last month. No cut-off scores applied, depression and anxiety symptoms are defined as absent or present.

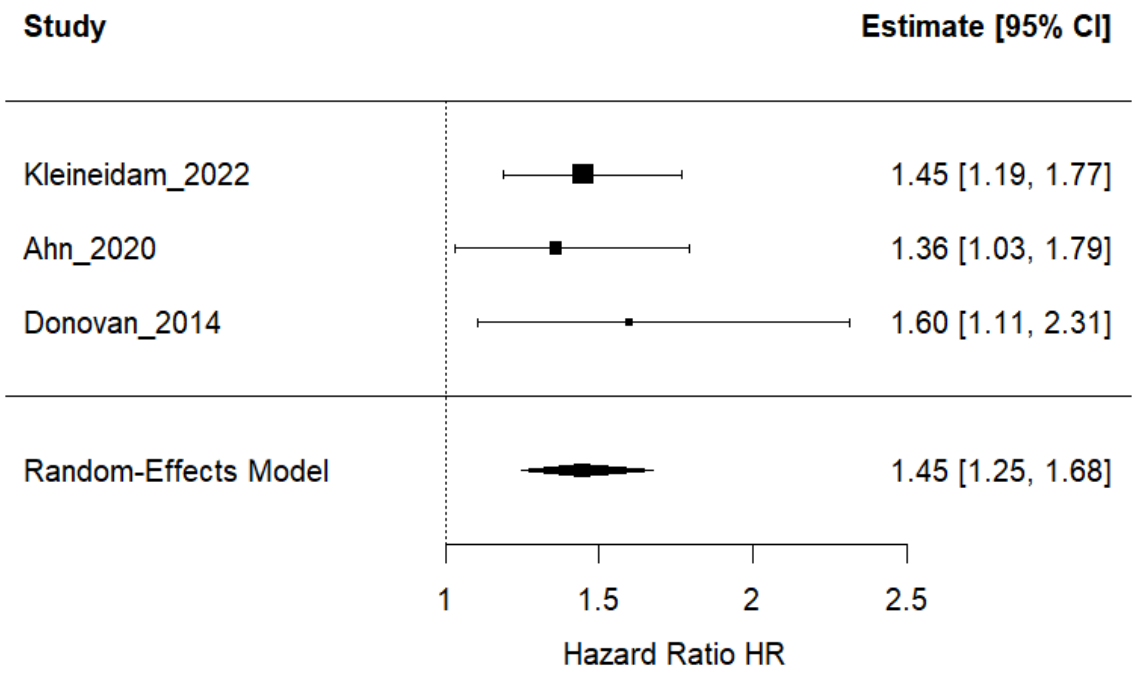
		Furthermore, Ahn et al (2021a) defined participants groups as having anxiety only, anxiety and depression, depression only, or no anxiety and depression.
Ahn et al., (2020)	Aspects of the Jessen et al., (2014) criteria (1) participant self-report of cognitive decline, taken as part of a clinical interview for purposes of the study (2) participants older than 60 years (3) no evidence of impairment on cognitive testing (27+ on MMSE; 0 on CDR).	Clinician administered and informant based Neuropsychiatric Inventory Questionnaire (NPI-Q; Kaufer et al., 2000). No cut-off scores applied, depression and anxiety symptoms defined as absent or present.
Donovan et al., (2014)	Authors use the term Subjective Cognitive Complaints (SCC). (1) Defined as self or informant perceived memory complaints. (2) CDR sum of boxes score of 0, with a score of 0.5 in the memory and/or judgement and problem-solving domains (3) cognitive testing within normal range	Clinician administered and informant based Neuropsychiatric Inventory Questionnaire (NPI-Q; Kaufer et al., 2000). Items were scored for symptoms presence and severity of affective symptoms and combined using factor analysis to obtain a latent affective factor comprising of depression, anxiety, irritability, agitation, apathy and disinhibition.

Depressive symptoms risk of cognitive decline in SCD

The three studies included in the meta-analysis provided data for 5,152 people with SCD at the baseline. Studies reported HRs for depression, though only one reported anxiety. A random-effects meta-analysis examined the association between baseline depressive symptoms and longitudinal cognitive decline. A pooled analysis revealed that higher depressive symptoms were associated with an increased risk of developing MCI or dementia (HR = 1.45, 95% C.I. [1.25, 1.68], p <.001). There was minimal evidence of variance across studies, $\tau^2 = 0$, $I^2 = 0\%$, $Q(2) = 0.48$, $p = .79$, however the small sample requires heterogeneity to be interpreted cautiously.

Figure 2

Forest plot for the effect sizes (HR) and confidence intervals for studies included in this meta-analysis examining whether SCD and depression increases risk of further cognitive decline.



Narrative Synthesis

Preliminary synthesis of findings

Seven longitudinal studies were included in this review, from six cohorts, as two papers drew on the same cohort (Ahn et al., 2021a; Ahn et al., 2021b). Each study explored the association between affective symptoms in older adults with SCD and risk of further cognitive decline overtime. The concept of SCD was defined across studies as self-reported changes to cognition, non-impaired neuropsychological tests with two studies including informant input (Ahn et al., 2020; Donovan et al., 2014)

Six studies indicated baseline depression in individuals with SCD increased or exacerbated the risk of developing further cognitive decline (Ahn et al., 2020; Ahn et al., 2021a; Ahn et al., 2021b, Dovovan et al., 2014; Kleineidam et al., 2022a; Kleineidam et al., 2022b). Presence of depression at baseline was also associated with faster cognitive decline (Ahn et al., 2021a; 2021b). Additionally, one study indicated that SCD presented before depressive symptoms (Kleineidam et al., 2022a). Furthermore, higher depressive symptoms at baseline which increased over time were associated with greater risk of further cognitive decline (Kleineidam et al., 2022a; Kleineidam et al., 2022b).

Raymond-Lessard et al. (2025) conducted comparisons between participants with SCD who progressed versus those who did not. The results of which indicated that participants with SCD-progressors scored significantly higher on the hopelessness subscale of the depression measure, compared to those who did not, thus indicating that feelings of hopelessness may present a role within depression and cognitive decline. However, depression intensity and relationship between cognitive decline and reported depression was not found to significantly differ between groups.

With regards to anxiety, the studies indicated less of a clear association to further cognitive decline in older adults with SCD. Raymond-Lessard et al. (2025) found that anxiety symptoms and intensity did not differ between individuals with SCD whose cognition deteriorated compared to those who did not. Furthermore, Ahn et al. (2021a) did not find any association between cognitive decline in participants with SCD and anxiety alone. However, performance in participants with anxiety and

depression was associated with greater decline in attention, whereas presence of depression was associated with greater decline in episodic memory and executive functioning skills.

Findings of this review tended to indicate that anxiety alone in older adults with SCD does not appear to be associated with an increased risk of further cognitive decline. However, depression does indicate an increased risk for older adults with SCD.

Exploration of similarities and differences across the studies

There were several similarities and differences across the seven studies, all of which may contribute to the results presented in this review.

Methodological approaches varied across the studies. Two papers applied linear-mixed effects models to examine the rate of cognitive change over time (Ahn et al., 2021a; Ahn et al., 2021b), whereas three of the papers used Cox-models to estimate time-to-event risk (Ahn et al., 2020; Donovan et al., 2014; Kleineidam et al., 2022a). One study applied latent process mixed models (Kleineidam et al., 2022b), and Raymond-Lesssard (2025) applied non-parametric group comparisons.

All studies included standardised neuropsychological testing, with reasonably consistent measures, such as the use of the MMSE, CDR and full versions of the WMS-III or WMS-R (Wechsler, 1989; 1997), providing consistency of measurement across the studies, despite some studies using longer neuropsychological test batteries. Furthermore, studies using linear mixed-effect models were able to indicate domain specific decline associated with depressive symptoms in episodic memory and executive functioning, and attentional decline with presence of anxiety and depression (Ahn et al., 2021a; Ahn et al., 2022b).

Each of the studies recruited participants from a range of settings such as memory clinics, research centres, community and primary care settings, reflecting SCD presentations across different samples. There was also overlap in the diagnostic criteria the studies applied for consideration of

defining objective cognitive decline, such as clinical opinion and application of NIA-AA (McKhann et al., 1984) and NINCDS-ADRDA (McKhann et al., 2011) criteria. Again, this overlap in recruitment methods and consistency in diagnostic criteria likely contributes to the similar findings of the studies.

Each study was longitudinal with participants undertaking annual to 18 monthly visits, with repeated neuropsychological testing. However, mood measures were often only taken at baseline, with only one study examining relationship of increasing or decreasing depression scores and the association with cognitive decline (Kleineidam et al., 2022a; Kleineidam et al., 2022b). Furthermore, the follow-ups across studies ranged from one to 12 years. While the follow-up lengths allowed for observation of progression, variances between studies in how many follow-ups participants attended may have influenced results. Furthermore, mood measures completed only at baseline may have resulted in changes in depressive and anxiety symptoms being missed, thus influencing findings.

Assessment of robustness

Assessment of robustness indicated several strengths and limitations across the studies included in the review.

Each study applied methods used for excluding MCI/AD at baseline within the SCD samples, increasing study validity. Although depth of assessment at baseline varied, with some studies completing semi-structured clinical interviews, informant involvement and neuropsychological testing, whereas others relied on self-report or testing alone. Therefore, differences in how SCD was assessed at baseline may introduce differences in study comparison.

Additionally, different measures were used to capture depression and anxiety symptoms across the studies. Three of the studies utilised clinician administered, informant-based measures such as the Neuropsychiatric Inventory-Questionnaire (Kaufer et al., 2000), or participant-based interviews using the Montgomery-Åsberg Depression Rating Scale (Montgomery & Åsberg, 1979). However, other studies used self-report measures, such as the Geriatric Anxiety Inventory, or the Geriatric Depression Scale, which one study modified to remove the cognitive concern item. Therefore, differences in measuring depression and anxiety may have influenced how symptoms were captured.

Furthermore, variation in these measures, such as emphasis on biological or emotional symptoms may influence how depression and anxiety were measured. However, associations across the studies regarding depression and cognitive decline were consistent, supporting the study robustness of conclusions.

The NOS was completed independently by two raters as a risk of bias measure, which indicated low risk of bias. An area that consistently indicated limitations was attrition rates within the studies, although all reported transparency and methods undertaken to adjust for these. Therefore, none of the studies were deemed to be at high risk of bias over multiple domains on the NOS.

Overall, despite variance within the studies and methodological differences, the findings of the studies in this review are consistent with the findings of depressive symptoms being associated with increased risk of cognitive decline in older adults with SCD, whereas the relationship with anxiety is less defined.

Study Quality

Overall, the NOS assessed all studies as having low risk of bias and good quality (Table 3**)**. The NOS for cohort studies suggested a length of four years being substantial time for outcomes to occur. Therefore, one study was scored 7/9 in quality owing to having a shorter follow-up time and recruiting from a research centre. One study did not adjust for confounding variables and so scored low on the comparability subscale of the tool.

Table 3
The Newcastle-Ottawa Quality Assessment of all included studies

	Selection				**Comparability**	**Outcome**			**Overall Rating**
	Representativeness of Exposed cohort (SCD)	Selection of the non-exposed cohort (SCD)	Ascertainment of Exposure (Depression and or anxiety)	Demonstration of outcome of interest (Neuropsychological tests)	Comparability of cohorts on the basis of design/analysis	Assessment of outcome	Was follow-up long enough for outcomes to occur	Adequacy of follow-up of cohorts	
Raymond-Lassard et al., (2025)	*	*	*	*	0	*	*	*	7/9
Kleineidam et al., (2022a)	*	*	*	*	**	*	*	*	9/9
Kleineidam et al., (2022b)	*	*	*	*	**	*	*	*	9/9
Ahn et al., (2021a)	*	*	*	*	**	*	*	*	9/9
Ahn et al, (2021b)	*	*	*	*	**	*	*	*	9/9
Ahn et al., (2020)	*	*	*	*	**	*	*	*	9/9
Donovan et al., (2014)	0	*	*	*	**	*	0	*	7/9

Discussion

This review aimed to explore literature examining whether anxiety and depression in older adults with SCD increased risk of further cognitive decline longitudinally. A total of seven studies were included and synthesised narratively, and three were used for a random effects meta-analysis. This indicated a pooled HR = 1.45, 95% CI [1.25, 1.68], p <.001, suggesting that depressive symptoms were associated with a 45% higher risk of developing MCI or dementia. Narrative synthesis supported the meta-analysis findings, indicating that older adults with SCD and depressive symptoms had an increased risk of further decline. The role of anxiety symptoms was less clear.

Moreover, the narrative synthesis indicated presence of depression not only increased risk but potentially accelerated rate of cognitive decline. Length of follow-up to detect progression was important. While there was variation in length of follow-up across the studies, most papers had a mean follow-up time of four years, in which conversion from SCD to MCI or AD was observed within this time.

However, it must be noted that the number of studies included in this review and meta-analysis was small, impacting the reliability of the results. Asymmetry funnel plots for publication bias were not conducted due to the small number of studies. Furthermore, such tests are less reliable for HRs (Debray et al., 2018). However, most of the studies found anxiety to have a non-significant effect, indicating that depression may present as the greater predictor of decline. These results contradict a previous meta-analysis containing 12 longitudinal papers, which concluded that depressive symptoms in people with SCD did not increase risk of clinical progression, whereas anxiety or SCD-related worry of developing objective cognitive impairment increased risk by 40% (Desai et al., 2021).

Collectively, the meta-analysis and narrative synthesis highlight that affective symptoms may be associated with increased risk of further cognitive decline in older adults with SCD. The review further supports the evidence base that SCD may reflect an earlier stage on the AD continuum.

Furthermore, progression towards MCI or AD can take several years, and therefore individuals reporting SCD and mood symptoms benefit from continued monitoring in clinical settings.

Limitations

There were several limitations within this review. Firstly, the search strategy did not include a separate search with grey literature, though one of the databases included (PsychINFO) included grey literature. The lack of grey literature combined with no asymmetry funnel plots means that there is a risk of publication bias. While themes and conclusions of the papers were considered, the smaller sample may have affected the results of the meta-analysis.

There were also several methodological flaws of the papers included in this review. While several studies applied the SCD-Initiative (Jessen et al., 2014) criteria for defining SCD, the definition and criteria used for defining decline into MCI or AD was varied. Several of the papers applied the older NIA-AAA (McKhann et al., 2011) criteria, despite the updated criteria from Jack et al. (2018).

Lastly, participants in each paper were well-educated and mostly female. While SCD and be associated with increased symptoms of depression in females (Oliver et al., 2022; Tomita et al., 2014). Males with SCD may present with more cognitive symptoms (Tomita et al., 2014; Wang & Tian, 2018). Therefore, sex differences in reporting of mood symptoms and SCD presentations may have influenced the outcomes of papers included in this review.

Conclusions

This review adds to the evidence base and supports with understanding of affective symptoms in older adults with SCD and longitudinal risk of further decline. Additionally, this review adds to suggestions that SCD may present as an earlier stage of MCI in some individuals. However, not all individuals who report SCD progress to MCI or AD. Therefore, future research should aim to continue to examine the potential link between affective symptoms as a predictor for future cognitive decline longitudinally in SCD cohorts.

Statements and Declarations

Competing interests

None to declare

Data availability statement

The data included in this review is available from the author upon request.

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Appendices

Appendix A: Eligibility Criteria and Search Strategy

Eligibility Criteria:

Population:

- Older adults (> 60 years) with SCD

Exposure:

- Depression and/or anxiety assessed using validated tools

Outcomes:

- Decline between baseline and follow-up cognitive testing
- For diagnostic studies, progression to MCI/dementia – no strict criteria as long as it is clearly defined

Study Design:

- Includes a follow-up phase. Exclude case studies/meta-analysis/Systematic Reviews/Cross-sectional studies

Language & Timeframe:

- English; published (2014 onwards)

Information Sources

- Databases: PubMed, PsychInfo, Scopus, Web of Science

Search Strategy:

PubMed	(("subjective cognitive decline"[tiab] OR "subjective memory complaints"[tiab] OR "memory complaints"[tiab] OR "cognitive decline"[tiab] OR "memory impairment"[tiab]) OR ("Cognitive Dysfunction"[MeSH] OR "Memory Disorders"[MeSH] OR "Dementia"[MeSH])) AND (depression[MeSH Terms] OR depressive[tiab] OR "major depressive disorder"[tiab] OR anxiety[MeSH Terms] OR anxious[tiab] OR "psychological distress"[tiab] OR "mood disorder"[tiab]) AND ("aged"[MeSH Terms] OR elderly[tiab] OR "older adults"[tiab] OR seniors[tiab] OR ageing[tiab] OR	2,404 hits

	aging[tiab]) AND ("2014/01/01"[PDAT]: AND English[lang] tiab = Title and Abstract MeSH = Medical Subject Headings Lang = Language	
PsycInfo	subjective cognitive decline OR "SCD" OR Subjective cognitive complaint OR subjective cognitive impairment OR subjective memory complaint AND depression or depressive disorder or depressive symptoms or major depressive disorder OR anxiety disorders or anxiety or generalized anxiety disorder AND older adults or elderly or geriatric or geriatrics or aging or senior or seniors or older people or aged 60+ AND follow up or follow-up OR	1,716 hits

	longitudinal studies or longitudinal research or longitudinal method or longitudinal AND Hazard ratio or odds ratio or risk ratio	
Web of Science	TS=("subjective cognitive decline" OR "subjective memory complaints" OR "subjective cognitive complaints" OR "memory complaints" OR "subjective memory decline" OR "subjective cognitive impairment") AND TS=(depression OR depressive OR "major depressive disorder" OR anxiety OR anxious OR "psychological distress" OR "mood disorder" OR "emotional symptoms") AND TS=("older adults" OR elderly OR "aged 60" OR geriatric OR "older people" OR seniors OR ageing OR aging) AND PY=(2014-2025) AND LA=(English)	1,131 hits

	TS = Topic Search PY = Publication Year	
Scopus	(TITLE-ABS-KEY ("subjective cognitive decline" OR "subjective memory complaints" OR "subjective cognitive complaints")) AND (TITLE-ABS-KEY (depression OR depressive OR "major depressive disorder" OR anxiety OR anxious)) AND (TITLE-ABS-KEY ("older adults" OR elderly OR "aged 60" OR "aged 65" OR geriatric)) AND (PUBYEAR > 2014) AND (LIMIT-TO (LANGUAGE , "English"))	1,410 hits* *705 (duplicated upon export)

Appendix B: PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Appendix
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Methods
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Methods
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Methods
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Methods
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Methods
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Methods
Study risk of	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers	Methods

Section and Topic	Item #	Checklist item	Location where item is reported
bias assessment		assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Methods
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Methods
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Methods
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Methods
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Methods
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Methods
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Methods
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Methods
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Methods
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Methods
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics.	Results
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Results
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Results

Section and Topic	Item #	Checklist item	Location where item is reported
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Results
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Results
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion
	23b	Discuss any limitations of the evidence included in the review.	Discussion
	23c	Discuss any limitations of the review processes used.	Discussion
	23d	Discuss implications of the results for practice, policy, and future research.	Discussion
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Methods
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Methods
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Methods
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Title Page
Competing interests	26	Declare any competing interests of review authors.	Statements and Declarations
Availability of data, code and	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Statements and

Section and Topic	Item #	Checklist item	Location where item is reported
other materials			Declarations

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

Section and Topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	Yes
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			

Section and Topic	Item #	Checklist item	Reported (Yes/No)
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	N/A
Registration	12	Provide the register name and registration number.	Yes

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

CHAPTER THREE: Bridging Chapter

The main findings from the systematic review and meta-analysis presented in this thesis portfolio indicated that depression in older adults with SCD increased their risk of developing MCI or AD (HR = 1.45, 95% C.I. [1.25, 1.68], p <.001). However, the sample was small due to availability of longitudinal studies that include anxiety or depression as predictors, rather than covariates, and studies which focused on exclusively older adult populations.

Longitudinal studies examining progression of SCD indicate an increased risk for developing mild cognitive impairment (MCI) or dementia. A meta-analysis consisting of 10 longitudinal studies found that individuals with SCD were 2.15 times more likely to develop MCI and 2.17 times more likely to develop dementia compared to people without SCD (Parfenov et al., 2020.) The mean lengths of follow-ups ranged from 4.91 – 5.27 years, The authors do not report their inclusion and exclusion criteria, so it is unclear whether the papers included middle-aged participants.

However, there has been less focus on shorter duration follow-up and personal experiences of SCD. The next chapters of this thesis portfolio present a longitudinal study, with a cohort of participants who undertook neuropsychological testing, as part of a previous study (Peterson et al., 2025). Participants were older adults with and without SCD and undertook baseline testing in 2023, with a follow-up repeat testing six months later. In the present study, participants from the same cohort were recruited to repeat neuropsychological testing in 2025, with an additional, novel word-pair learning task developed to assess accelerated forgetting. Additional interviews were completed with participants who identified as having SCD in 2023, to gain an understanding of their experiences. All participants were over the age of 60, in-keeping with the World Health Organisation definition of old age (WHO, 2002).

Overall, the results of the systematic review and meta-analysis along with the empirical papers presented in the next two chapters add to the growing evidence base of understanding SCD trajectory longitudinally using neuropsychological tests, as well as understanding the impacts of living with SCD.

CHAPTER FOUR: The Use of Online Neuropsychological Testing for Assessing Early Cognitive Changes in Subjective Cognitive Decline and Mild Cognitive Impairment

Short Title: Online neuropsychological testing with older adults with subjective cognitive decline over a two-year period

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Key words: Subjective Cognitive Decline, longitudinal, older adult, online cognitive assessment, neuropsychology, cognitive decline

Word count: 8,815* **Abstract word count:** 231

* Prepared for publication in The Clinical Neuropsychologist. As per journal submission guidelines, word count includes tables, figures and references

Abstract

Background: Remote neuropsychological assessment could enable increased monitoring of subjective cognitive decline (SCD). However, there is an absence of longitudinal sensitivity and feasibility data that requires evaluation.

Methods: Older adults (≥60 years) who previously completed online testing (NeurOn via Mantal) in 2023 were re-assessed two years later (2025). SCD status was defined by a score of ≥20 on the first 12-items on the Cognitive Change Index (CCI). Cognitive outcomes were measured through a range of tests, with a subset completing the Verbal Associative Learning and Memory Test (VALMT) with 55-minute and 24-hour delays. Parametric or non-parametric tests were applied according to assumptions.

Results: Twenty-six participants completed NeurOn; 16 provided analysable VALMT data. None of the participants reported incident mild cognitive impairment. From 2023 to 2025, CCI scores increased (greater subjective decline), Geriatric Depression Scale (GDS) scores decreased, and performance on most NeurOn tasks was stable; TMTA completion time improved (faster) at follow-up. In the new-SCD subgroup (n=12), Friedman tests across baseline/6-month/2025 showed no significant change on NeurOn measures. On VALMT, recall declined from learning to 55-min and 24-hour recall, whereas 24-hour recognition exceeded 24-hour free recall.

Conclusions: Fully remote cognitive follow-up over two years in SCD is feasible and shows largely stable objective performance despite increased subjective complaints; accelerated forgetting is evident on a verbal associative task. Larger, pre-registered studies using mixed-effects modelling, multiple-comparison control, and reliable change indices are warranted.

Introduction

The UK has an ageing population with Census data revealing the older adult population has risen from 8.3 million (14%) in 2001, to 9.2 million (16.4%) in 2011 and 11 million (18.6%) in 2021 (Office of National Statistics [ONS], 2001; ONS, 2011; ONS, 2021). Age presents an increased risk for developing neurogenerative diseases, particularly dementia (Van der Flier & Scheltens, 2005; Hou et al., 2019).

Dementia is a progressive disease, causing gradual decline in cognitive skills and affective changes (Carr, 2017; Hobson, 2025). The term dementia is overarching and refers to a range of neurodegenerative conditions. Alzheimer's Disease (AD) is the most prevalent type of dementia globally (Alawode et al., 2022; Tahami-Monfared, 2022). Currently, AD is non-curable, though medications for symptom management may be effective with earlier diagnosis (Helaly et al., 2021; Rassmussen & Langerman, 2019).

Therefore, earlier detection and prevention for AD have been prominent in NHS policy, with the NHS Ten-Year Plan (NHS England, 2019; 2025) pledging to prioritise new dementia therapies. Neuropsychological assessments are recommended to assist with the dementia diagnostic process (National Institute for Clinical Excellence [NICE], 2018).

Symptoms of AD can take years to present, and therefore individuals may experience a phase of subtle cognitive changes, which do not markedly impact daily functioning or present on formal neuropsychological assessment (Cedres et al., 2019; Jiwtode et al., 2021; Rabin et al., 2017; Sperling et al., 2011). Therefore, individuals may experience subjective cognitive decline (SCD) prior to developing AD. The SCD Initiative (SCD-I; Jessen et al., 2014) define SCD as self-reported cognitive decline without objective cognitive impairment. This definition mostly concurs with The National Institute on Aging and Alzheimer's Association (NIA-AA; Jack et al., 2018), which defines a "Cognitively Unimpaired" group within its stages of Alzheimer's continuum. Similarly, this group is defined as cognitively unimpaired individuals who report SCD, and/or may show subtle deterioration on repeated neuropsychological tests (Jack et al., 2018). Approximately 50 – 80% of adults aged over

70 report SCD, (Jessen et al., 2021). Furthermore, SCD may represent an increased risk for future decline into mild cognitive impairment (MCI) (Mitchell et al., 2014).

MCI, in which changes to cognitive skills are more pronounced but with abilities to maintain similar levels of pre-morbid functioning, may be considered a prodromal stage to AD (Palmer, 2007; Peterson et al., 2001; 2014). Chen et al. (2022) conducted a meta-analysis of 18 studies focusing on developing models to predict the MCI to AD conversion rate, which ranged from 14 – 87%. However, differing definitions of MCI, follow-up periods, sample characteristics and methodical practices in the literature may have contributed to the inconsistencies of the results.

Conversion rates of SCD into MCI have been considered in previous research. A meta-analysis consisting of 28 studies indicating annual conversation rates of SCD into MCI to be 6.67%. However, the author notes inconsistent follow-up periods and methods influenced results (Mitchell et al., 2014). Furthermore, methods of diagnosing MCI (e.g. neuropsychological testing) were not reported.

Neuropsychological testing may serve a crucial role in supporting with defining the profile of SCD, to better understand which cognitive domains are affected and for monitoring overtime. Fonseca et al. (2015) administered a full neuropsychological testing battery to 62 older adults with reported SCD from an NHS memory clinic. Participants returned to the clinic every two years, though did not repeat testing. Over the one-to-nine-year follow-up period, with an average of three years, 15 (24%) participants obtained an MCI diagnosis. Furthermore, being over 61 years at the time of developing SCD was noted to be a potential risk for MCI. Additionally, retrospective analysis of cognitive assessment highlighted these participants indicated reduced performance on the CAMCOG-R (Roth, 1999) and Trail Making B tests only. While testing was not repeated throughout the study, and the authors do not state which domains of the CAMCOG-R showed more difficulty, neuropsychological testing may have captured early decline at the pre-MCI stage.

Similarly, Ismail et al. (2019), examined decline in older adults with SCD and mild behaviour impairment (MBI) over a three-year period. Decline was determined by changes to the Clinical

Dementia Scale (CDR; Morris, 1993). This measure consists of six domains relating to cognitive and functional skills. Participants who had both SCD and MBI showed the highest risk rate for developing further decline over the study period. In conjunction with Fonseca er al (2015), decline from SCD into MCI could present within a three-year timeframe.

Thomas et al. (2018) categorised participants with SCD by neuropsychological test performance, defining an "early SCD" group, which demonstrated impaired process scores (e.g. learning slope, intrusion errors) on the Rey Auditory Verbal Learning Test (Rey, 1964), but otherwise normal neuropsychological testing. The "late SCD" was characterised by impaired scores on two or more neuropsychological tests in different domains. The battery involved the Boston Naming test (Kaplan, 1989), semantic fluency, Trail Making Tasks A and B. Both early and late SCD groups had a 2.5 - 3.4 times higher risk of developing MCI than the control group. While the authors do not report scores obtained on neuropsychological assessment, their findings indicate SCD may follow a trajectory. Earlier SCD may demonstrate subtle verbal memory impairments, with possible involvement of other cognitive domains in "later" SCD.

Therefore, continued monitoring of people with SCD who may be at risk of further cognitive decline with the use of neuropsychological testing may be beneficial. However, there are several practical implications to this, such as the cost, time burden on clinicians and demands placed on patients (Habibi, 2020). Therefore, online neuropsychological testing offers the possibility to offer repeat testing overtime, without travel. Additionally, this would be in-keeping with the NHS Ten-Year Plan to utilise more digital platforms (NHS England, 2019).

The implementation of remote neuropsychological testing increased during the Covid-19 Pandemic and have been shown to increase accessibility (Krynicki, Hacker & Jones, 2022; Webb et al., 2021). Furthermore, online neuropsychological assessments inclusive to a range of cognitive domains have been shown to differential accurately between SCD, MCI and AD (Van Mierlo et al., 2017), and healthy controls and SCD (Atkins et al., 2022).

Previous studies have used neuropsychological assessment to differentiate and define SCD within study participants with retrospective, limited examination of individual cognitive test scores. Furthermore, Jutten et al. (2021) notes that traditional neuropsychological testing may not be sensitive enough to detect subtle changes seen in earlier stages of decline. Therefore, a potential gap within this subject reflects the use of longitudinal observation with repeated neuropsychological testing to understand how SCD nay change overtime, particularly using online testing methods.

The present study consists of participants who undertook online neuropsychological testing using a set battery as part of a previous study (Peterson et al., 2025). Within this study, participants were older adults with and without SCD. Baseline testing was completed in 2023, with follow-up repeated testing approximately six-months later. The aim of Peterson et al, (2025) was to assess the test-retest validity of these online tests. The present study builds on this previous study by recruiting the same participants and repeating these tests in 2025.Utilising data from the previous two timepoints provides an opportunity to examine for any changes to cognition overtime.

Furthermore, given the potential indication that SCD may present with process difficulties on verbal memory tests (Thomas et al., 2018), this study will include an additional, novel online verbal memory measure. The Verbal Associative Learning and Memory Test (VALMT, McGibbons et al., 2022) incorporates a 55-minuite and 24-hour delay; to examine how long participants retain word-pairs they have learned over a longer period than typical verbal memory tests. Therefore, highlighting the possible role of verbal memory within SCD.

Aims and Hypotheses

There are two aims to this proposed study:

1. To examine whether participants with SCD who undertook online baseline testing in 2023 demonstrate changes to cognitive performance on repeat testing (2025).
2. To examine how participants with and without SCD perform on a verbal memory specific test at the learning, 55-minute and 24-hour delay trials

We hypothesise that:

1. A proportion of participants with SCD will have progressed to MCI.
2. On repeat cognitive testing, participants with MCI will demonstrate impairments which will have been indicated in previous testing.

Methods

Ethical Approval

This project received ethical approval from the University of East Anglia Faculty of Medicine and Health Science Research Ethics Subcommittee (ETH2425-2236). Participants provided informed consent via online consent forms.

Materials

NeurOn and Mantal Software Platforms

Participants completed online neuropsychological testing provided by NeurOn (**http://neuropsychology.online/**) which was accessed via the Mantal software platform (**http://mantal.co.uk/**). Mantal, created by AAH Software Limited. An application programming interface (API) allowed for the two systems to be integrated. Participants accessed Mantal via their individualised login, which was established as part of the Peterson et al. (2025) study. Participants also had a unique code linked to their login email, which was used to link participants test scores across all timepoints.

Cognitive tests

Participants completed the NeurOn neuropsychological tests remotely via their Mantal platform login details. Participants were advised to complete the tests on a computer with mouse and keyboard, or a tablet. Table 1 shows the details and the order in which tests were completed.

All tests were included for the present study to enable direct comparison and exploration of changes to test performance within the same group of participants. Peterson et al., (2025) examined

the test-retest reliability of the neuropsychological tests used in the present study within an older adult population with and without SCD. Results of which ranged from poor to high test-retest across different tasks.

Table 1
Online Neuropsychological Tests

Test name	Cognitive domain	Description
Picture Encoding	Visual learning	The task instructs participants they are going to be shown a series of pictures and to remember stimuli and where it was displayed on screen. Pictures of easily recognisable objects are shown in different locations (upper, lower right or left).
Simple Reaction Time (SRT)	Reaction time	Participants are presented with repeated stimuli which they had to respond to as quickly as they could
Digit Span Backwards (DSB)	Working memory	A series of digits are presented one at a time, with participants instructed to recall the digits in reverse. As the test progresses, the digit series becomes longer. The test is discontinued after two consecutive incorrect trials.
Picture Recognition (PR)	Visual memory	The stimuli from the Picture Encoding task is shown again in a different order, and with novel stimuli not shown in the previous stage (distractors). Participants are asked whether they recognise the picture displayed. A response of "Yes" leads to a question prompting participants to answer where on the screen the item was displayed.
Word Encoding	Verbal learning	The task instructs participants they are going to be shown a series of words and to remember stimuli and where it was displayed on screen. Commonly used words are shown in different locations (upper, lower right or left).
Sustained Attention to Response (SAR)	Attention	Participants are shown a string of numbers and instructed to respond to each number, with exception of one (the no-go target). The task consists of 225 trials; thus, participants must hold attention throughout. Reaction times are measured for each response, marking as "Too Soon" or "Anticipatory", which is indicative of a hasty response, and not in-keeping with response times should the instructions being followed correctly
Word Recognition (WR)	Verbal Memory	The stimuli from the Word Encoding task is shown again in a different order, and with novel stimuli not shown in the previous stage included (distractors). Participants are asked whether they recognise the word displayed. A response of "Yes" leads to a question prompting participants to answer where on the screen the item was displayed .
Trail Making Test A (TMTA)	Psychomotor speed, Attention, Visual Scanning	Participants are shown a series of numbers inside circles and must click on each in numerical order and complete the task as quickly as possible.

Trail Making Test B (TMTB)	Same as above with Executive Functioning	Participants are shown a series of numbers and letters inside circles and must clock on each in numerical and alphabetical order, alternating between the two e.g. 1, A, 2 B, 3 C etc. As quickly as possible.

Testing could be completed within 20 – 30 minutes if completed in one session. To assist with fatigue or boredom, participants were advised to have a break between questionnaires and neuropsychological testing. The encoding and recognition tasks were approximately 10 minutes apart.

These tests were selected to provide a direct comparison to participants' previous scores from the Peterson et al. (2025) study. Furthermore, research into the neuropsychological features of preclinical AD, including SCD and MCI, have used similar neuropsychological tests and indicated impaired performance within this population (Arnáiz, & Almkvist, 2003; Galvin et al., 2005; Rivera-Fernández et al, 2021).

The Verbal Associative Learning and Memory Test (VALMT)

Participants were also invited to complete the VALMT (McGibbon et al., 2022). This task involved learning word pairs, and examines encoding and recall, with a 55-minute and 24-hour delay.

The VALMT has demonstrated ability to detect differences in encoding in older adults (60 – 69 years), such as "faster learners", who require less learning trials and "slower" learners who needed more learning trials before meeting the 12-word criterion. "Slower learners" performed poorly across recall times compared to younger adults and "faster learners". Furthermore, "slower learners" also reported greater cognitive complaints, indicating this group may be at increased risk of accelerated forgetting and further decline (McGibbon et al., 2022).

Cognitive Change

The Cognitive Change Index (CCI; Rattanabannakit et al., 2016) is a 20-item self-report questionnaire relating to perceived cognitive decline in older adults. The measure has been found to demonstrate good internal consistency ($\alpha = .96$). A score of ≥ 20 within the first 12-items is indicative of SCD, in-keeping with the author's scoring.

Mood Measures

In-keeping with Peterson et al. (2025), mood measures were used in the present study to examine for changes to self-reported anxiety and depression scores between baseline (2023) and follow-up (2025) testing.

The Geriatric-Depression Scale (GDS; Sheikh, & Yesavage, 1986) is a fifteen-item self-report questionnaire designed to measure depression symptoms in older adults. The shorter version of this measure was opted for ease of completion, particularly with regards to attentional difficulties and fatigue (Kurlowicz & Greenberg, 2012). Furthermore, the short form demonstrates good validity and reliability (Sheikh & Yesavage, 1986).

The Geriatric Anxiety Inventory (GAI; Pachana et al., 2007) is a twenty-item questionnaire developed to measure anxiety symptoms in older adults. The measure has been found to have good internal consistency, $\alpha = .91$ within the general older adult population (Pachana et al., 2007).

Participants

To be invited to the study, participants had to meet the following criteria:

Inclusion:

- Aged over 60+
- Previously participated in the Peterson et al. (2025) study and provided consent to be contacted regarding future research on their original consent form
- Ability to give informed consent
- Able to use computer/tablet to complete consent form and neuropsychological tests
- Fluent in English

Exclusion:

- Diagnosis of neurological or neurodegenerative conditions (excluding MCI)
- Being under secondary mental health services

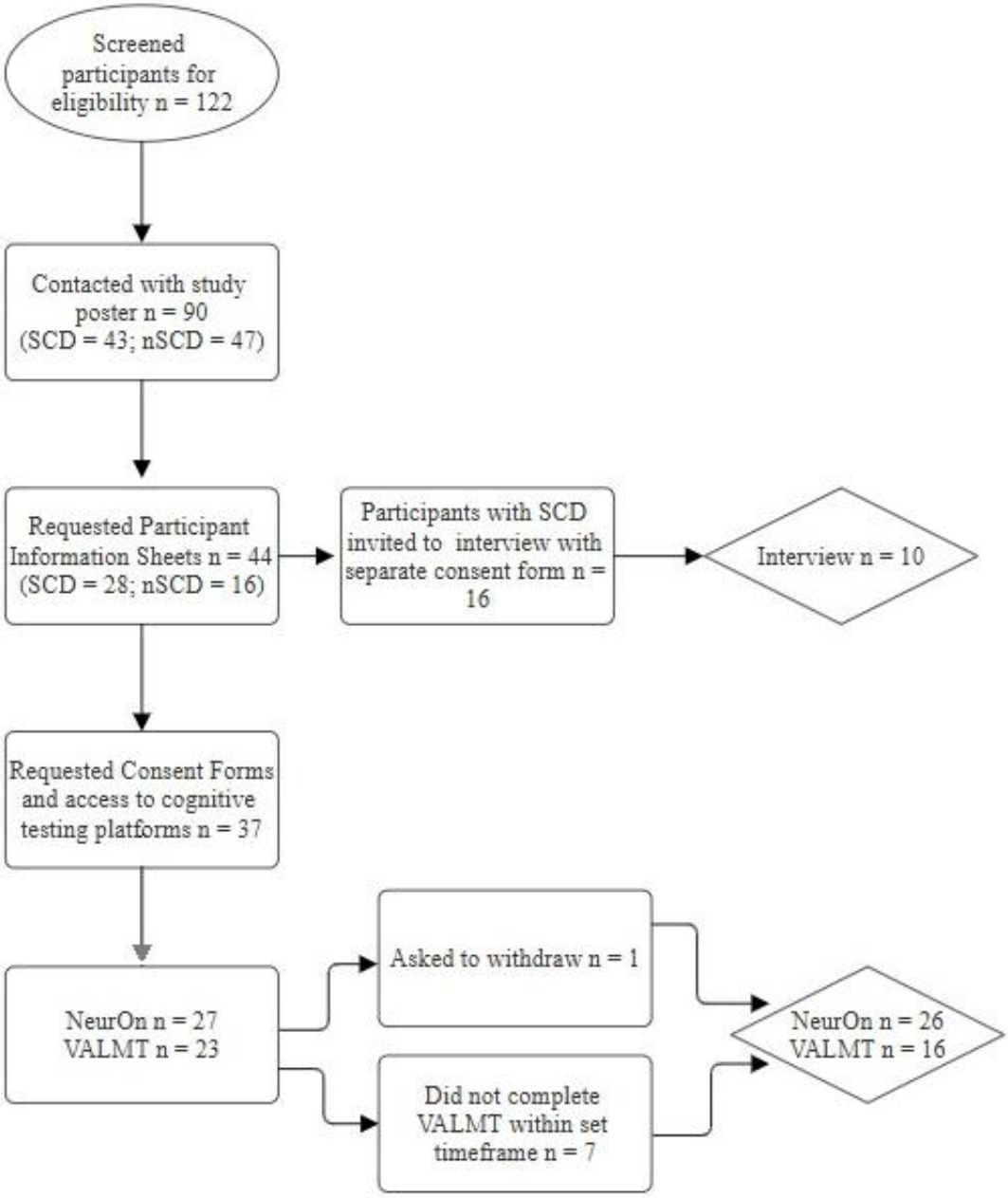
G-Power analysis (Faul et al., 2009) was conducted to estimate required sample size. Assuming medium effect sizes and parametric testing, alpha = .05 and power =.80, sample sizes of 12 and 28 were indicated for research question one (one-tailed) and research question two respectively.

Recruitment

Following ethical approval, all participants meeting inclusion criteria were approached and provided with details of this study. Recruitment process is shown in Figure 1.

Figure 1

Participant recruitment



Note. SCD = participants who reported subjective cognitive decline, nSCD = participants who did not report SCD within the Peterson et al (2025) study

Procedure

Participants who had taken part in the previous study and had consented to be contacted for future research were contacted and provided consent to enrol in the study via an online consent form shown to them when logging into the Mantal platform. Participants were also asked if they have been given a diagnosis of MCI since previous participation, indicated with a "Yes/No" response. If participants met inclusion, they were taken to a demographic questionnaire. Following this, participants completed the CCI and mood questionnaires, before proceeding to the neuropsychological tests.

Participants accessed the VALMT via the developer's platform and were issued with a unique code. They were then presented an abbreviated version of the Memory Complaints Scale (MSC, Vale et al., 2012). While part of the VALMT platform, this test was not examined in detail in analysis, as participants had completed the CCI. Following the questionnaires, participants proceeded to the VALMT test.

Participants used their unique code to return to the platform after 55 minutes and presented with a cue-word and again prompted to type in the pairing word. The same process was repeated at 24 hours. Additionally at 24 hours, there was a recognition task in which participants are presented with word-pairs and asked if they recalled seeing them. For each trial, the cue-words appeared in a different order, though used the same 12 word-pairs throughout.

Analysis Plan

Research Question One

Prior to conducting the analyses, the data was explored for outliers and assumption testing, which highlighted several variables violated normality and contained outliers. Therefore, owing to these factors and the small sample size, non-parametric tests were applied to variables (neuropsychological testing) that did not meet parametric assumptions. Variables which met parametric assumptions were analysed using t-tests.

To avoid potential duplication with research question two, not all subparts of tests were included in the analysis. Frequencies within the subtests of the main tests were explored, and where participants predominantly obtained a score of zero at both time points across the data, it was decided to omit these from the analysis. This was most frequent for number of incorrect responses on a test, and so it was decided to prioritise correct responses, which showed more variance within the scores. Number of error responses for the sustained attention to response (SAR) was included as these scores related to the timing of participants' reaction time and thus yielded crucial information for this test.

Research Question Two

Assumption testing using Shapiro-Wilk tests showed that several of the variables were normally distributed across all timepoints (baseline [2023]; six-month follow-up and 2025- follow-up). However, most variables violated normality across one of more timepoints. Furthermore, boxplots revealed outliers in some of the variables and the assumption of sphericity was not met for several variables. Therefore, a Freidman's test was used due to a smaller sample size with assumption violations which could undermine a repeated-measures one-way ANOVA (Stoltzfus, 2016).

VALMT Data

Timepoints within the VALMT data were examined for assumption violations using Shapiro-Wilk tests. The learning trail and 55-minute delay trail were normally distributed, the 24-hour recall trial duration did not meet this assumption. Furthermore, scores on the 55-minute violated this assumption, though scores for the 24-hour delay recall and 24-hour recognition were normally distributed.

Therefore, given the presence of assumption violations and smaller sample size, Freidman tests were used to examine changes across duration times and trials. Significant findings were followed-up with Wilcoxon signed-rank tests as post-hoc tests. A paired t-test was used for differences to 24 delayed recall and 24 hour delayed recognition. Spearman's correlations were applied to

examine associations between age and performance on the learning trials in terms of durations, errors and attempts until meeting learning criterion.

Results

Overall, 26 participants completed NeurOn testing, with participant demographics shown in Table 2. None of the participants reported having a diagnosis of MCI at the time of participation.

Table 2
Participant demographics for the full sample

Sex		
	Female	11 (42%)
	Male	15 (58%)
Age (years)		
	Total	70.8 (6.5)
	Female	70.7 (7.6)
	Male	70.9 (5.8)
Ethnicity		
	White British	26 (100%)
Highest Education		
	GCSE*	4 (15%)
	O-Levels*	3 (12%)
	Bachelor's Degree*	11 (42%)
	Post Graduate Certificate*	5 (19%)
	Master's Degree*	3 (12%)
Employment Status		
	Part-time	3 (11%)
	Retired	23 (89%)

* or equivalent

Of the 26 participants, 14 had reported SCD in the previous study. This group was identified as the original-SCD group (O-SCD). Of these, 36% (N = 5) were female, and 64% (N = 9) were male. The mean age for this group was 72.3 (7.3) years. The remaining 12 participants, who were not categorised as not having SCD in the previous study, all scored above 20 on12 items on the CCI (Rattanabannakit et al., 2016) indicating SCD. Therefore, this group was identified as the new-SCD group (N-SCD). This group comprised of a half male-female divide (N = 6), with a mean age of 69.1 (5.1) years. Table 3 displays the group comparisons, which indicated the O-SCD group scored significantly higher on the depression and cognitive changes measure.

Table 3

Differences between the O-SCD and N-SCD groups

Measure	O-SCD	N-SCD	Test Statistic	*p*	Effect Size
Age (years)	*M* = 72.3 (7.3)	*M* = 69.1 (5.1)	*t*(24) = 1.27	.22	*d* = .50 (medium)
Sex					
Female	n = 5	n = 6	$X^2(1) = .54$	.54	φ = .14 (large)
Male	n = 9	n = 6			
Geriatric Depression Scale (GDS)	*Mdn* = 2.0	*Mdn* = 0	*U* = 47.0, *z* = -2.02	.04*	*r* = .40 (medium)
Geriatric Anxiety Inventory (GAI)	*Mdn* = .50	*Mdn* = .50	*U* = 81.50, *z* = -.14	.89	*r* = -.03 (very small)
Cognitive Change Index (CCI)	*M* = 33.93 (10.37)	*M* = 25.92 (4.32)	*t*(24) = 2.64	.02*	*d* =.98 (large)

* Statistically significant

Research Question One

The first research question explored whether there had been any deterioration on performance on neuropsychological tests between baseline testing in 2023 and follow-up testing in 2025. As all participants reported SCD, the whole sample was included in the analysis. Table 4 displays the descriptive statistics and comparisons for the mood measures, CCI and tests analysed for this research question

Wilcoxen-signed rank tests were conducted to examine for changes to the mood measures GDS, GAI, and perceived cognitive complaints CCI between testing at baseline (2023) and 2025. Wilcoxon-signed rank tests were also used to examine for differences on testing scores between the two timepoints for the following variables: SRT average time, PR correct responses and correct position, SAR average time, and TMTB completion time.

Paired t-tests were also used to assess for deterioration for the following variables: DBS correct, DSB longest span, SAR Anticipatory and Too Soon Errors, WR correct, WR Correct Position and A (TMTA) completion time.

Table 4

Descriptive Statistics for the mood measures, self-report cognitive change and neuropsychological tests

Measure	Baseline 2023	Follow-Up 2025	Test Statistic	*p*	Effect Size
Geriatric Depression Scale	2.27 (3.16)	1.50 (2.16)	z = -2.27	.02*	r = .45 (Moderate)
Geriatric Anxiety Inventory	2.62 (4.39)	1.69 (3.21)	z = 1.32	.19	r = -.26 (Small)
Cognitive Change Index	19.81 (6.18)	30.23 (8.91)	z = 4.37	<.001*	r = .86 (Large)
Simple Reaction Time Average Time (ms)	338.50 (72.00)	387.95 (189.44)	z = 1.44	.15	r = .30 (Small)
Digit Span Backwards N Correct	6.04 (7.73)	7.16 (4.48)	$t(24)$ = -1.43	.08	d = -.29 (Small)
Digit Span Backwards Longest Span	4.44 (2.97)	5.28 (2.70)	$t(24)$ = -1.55	.07	d = -.31 (Small)
Picture Recognition N Correct	27.84 (2.29)	28.16 (1.86)	z = .51	.61	r = .10 (Small)
Picture Recognition Correct Position	11.96 (2.76)	12.08 (2.10)	z = -.33	.74	r = .07 (Very Small)
Sustained Attention to Reaction Average Time (ms)	308.64 (149.59)	758.61 (317.83)	z = 1.12	.26	r = .15 (Small)
Sustained Attention to Reaction Anticipatory and Too Soon Errors	100.36 (61.6)	109.12 (58.82)	$t(24)$ = -1.37	.09	d = -.27 (Small)
Word Recognition N Correct	24.56 (2.96)	23.88 (3.90)	$t(24)$ = .84	.41	d = -.17 (Small)
Word Recognition Correct Position	7.36 (3.69)	8.20 (3.35)	$t(24)$ = -1.29	.21	d = -.26 (small)
Trail Making Test A Completion Time (ms)	33148.44 (10315.01)	26548.72 (10195.10)	$t(24)$ = 2.74	.01*	d = .55 (Medium)
Trail Making Test B Completion Time (ms)	46902.94 (19533.75)	49444.25 (41475.47)	z = 1.44	.15	r = -.30 (Medium)

* Statistically significant

The results showed a significant difference in depression scores between 2023 baseline and 2025 follow-up testing, indicated less self-reported low mood. The CCI scores increased over the timepoints, indicating an increase in self-reported cognitive decline.

On neuropsychological testing, only one test showed significant difference in time between timepoints. Completion time for the TMTA were lower, indicating faster processing speed, visual scanning and visual attention on this task.

Research Question Two

None of the participants reported a diagnosis of MCI, and so this research question was adjusted to examine changes to tests scores within the N-SCD group across timepoints (baseline 2023, follow-up 2024 [six +/- one month from baseline] and follow-up 2025).

This group consisted of 12 participants overall, although three participants failed to complete all tests at the 6-month follow-up time. All had completed all testing in 2023 and 2025.

The Freidman's tests did not reveal any significant effects of time or group across the three time points. The descriptive statistics and results for each variable are presented in Table 5

Table 5

Descriptive Statistics and Freidman's Test results for the cognitive testing variables

Measure	N	Mean	(SD)	Test Statistic (X^2)	*df*	*p*	Effect Size (W)
Simple Reaction Task Average Time SRT (ms)							
Baseline 2023	12	317.80	(59.02)	2.18	2	.34	.10 (Small)
Follow-up 2024	11	353.88	(63.87)				
Follow-up 2025	12	347.83	(64.81)				
SRT Number Incorrect							
Baseline 2023	12	.73	(2.10)	.67	2	.72	.03 (Very Small)
Follow-up 2024	11	.64	(2.11)				
Follow-up 2025	12	.18	(.41)				
Digit Span (DS) Correct							
Baseline 2023	12	6.40	(5.06)	3.85	2	.15	.19 (Small)
Follow-up 2024	10	6.00	(4.52)				
Follow-up 2025	12	8.90	(4.46)				
DS Incorrect							
Baseline 2023	12	2.60	(.70)	2.69	2	.26	.13 (Small)
Follow-up 2024	10	3.20	(1.40)				
Follow-up 2025	12	2.10	(1.23)				
DS Longest							
Baseline 2023	12	4.60	(3.03)	3.39	2	.18	.17 (Small)
Follow-up 2024	10	4.40	(2.88)				
Follow-up 2025	12	6.30	(2.67)				
Picture Recognition (PR) Correct							
Baseline 2023	12	28.10	(1.66)	4.21	2	.12	.21 (Small)
Follow-up 2024	10	29.10	(1.29)				
Follow-up 2025	12	28.10	(1.37)				

PR Incorrect							
Baseline 2023	12	.50	(.71)	.42	2	.81	.02 (Very Small)
Follow-up 2024	10	.40	(.70)				
Follow-up 2025	12	.50	(.53)				
PR Position Correct							
Baseline 2023	12	11.90	(2.28)	2.18	2	.38	.17 (Small)
Follow-up 2024	10	12.90	(2.28)				
Follow-up 2025	12	11.30	(2.26)				
Sustained Attention to Response (SAR) Rection Speed (ms)							
Baseline 2023	12	95.70	(44.90)	4.20	2	.12	.21 (Small)
Follow-up 2024	10	89.10	(42.43)				
Follow-up 2025	12	95.10	(54.44)				
SAR Errors							
Baseline 2023	12	118.90	(53.71)	.46	2	.79	.02 (Very Small)
Follow-up 2024	10	129.90	(46.68)				
Follow-up 2025	12	120.70	(50.68)				
SAR Correct							
Baseline 2023	12	296.92	(154.23)	.36	2	.12	.01 (Very Small)
Follow-up 2024	10	235.38	(86.24)				
Follow-up 2025	12	306.07	(83.93)				
Word Recognition (WR) Correct							
Baseline 2023	12	26.20	(2.44)	4.11	2	.13	.21 (Small)
Follow-up 2024	10	25.10	(3.21)				
Follow-up 2025	12	24.30	(3.27)				
WR Position Correct							
Baseline 2023	12	.90	(1.29)	.18	2	.92	.001 (Very Small)
Follow-up 2024	10	2.10	(1.73)				
Follow-up 2025	12	1.60	(2.07)				
WR False Alarms							
Baseline 2023	12	8.60	(3.66)	1.28	2	.53	.06 (Very Small)
Follow-up 2024	10	7.90	(4.01)				
Follow-up 2025	12	8.90	(3.11)				
Trail Making Test A Time (TMTA) (ms)			(7011.26) (8548.44)	2.89	2	.24	.16 (Small)

Baseline 2023	12	29076.66	(10004.20)				
Follow-up 2024	9	30806.44					
Follow-up 2025	12	26322.94					
TMTA Errors							
Baseline 2023	12	.56	(.88)	2.11	2	.35	.12 (Small)
Follow-up 2024	9	1.00	(1.11)				
Follow-up 2025	12	.44	(1.01)				
Trail Making Test B Time (TMTB) (ms)							
Baseline 2023	12	41661.00	(14243.15)	2.89	2	.24	.16 (Small)
Follow-up 2024	9	41655.64	(11811.48)				
Follow-up 2025	12	39822.66	(11026.70)				
TMTB Errors							
Baseline 2023	12	2.33	(5.24)	2.00	2	.37	.37 (Small)
Follow-up 2024	9	.22	(.67)				
Follow-up 2025	12	.33	(0.71)				

Overall, none of the neuropsychological tests revealed significant changes across a range of tests within the N-SCD group between baseline testing in 2023, six-month or 2025 follow-up testing.

The Verbal Associative Learning and Memory Test (VALMT) McGibbon et al. (2023)

A total of 23 participants completed the VALMT. Seven participants did not complete the delayed recall tests within the specified times (55 minutes +/-10 minutes and 24 hours +/- 4) hours and were removed from analyses. The remaining 16 participants completed the tests within the time parameters. Descriptive statistics are shown in Table 6.

Table 6
Descriptive Statistics for the variables

	M	SD
Age	69.63	6.78
Subjective Memory Complaints Score	3.44	1.71
Learning Phase Duration (mins)	10.43	5.10
Learning Phase Attempts	53.06	33.53
Learning Phase Total Errors	41.06	33.53
Number of Pairs Learned	12.00	0
55 Minute Delay Duration (mins)	2.18	1.00
55 Minute Delay Word Pair Recall	4.69	3.22
24 Hour Delay Duration (mins)	3.31	1.17
24 Hour Delay Word Pair Recall	4.25	3.17
24 Hour Delay Word Pair Recognised	8.75	2.11

The mean age of the sample was 69.63 years (6.78). Females accounted for half the sample (N =8) with a mean age of 67.38 years (6.46). Males (N =8) had a mean age of 71.88 years (6.42). A Mann-Whitney-U indicated there was no significant difference between female and male participants in terms of age, U =18.50, z =-1.42, r = .36.

Age was positively correlated with learning trial duration, (ρ =.70, p <.001), number of learning trial attempts, (ρ = .69, p = .001) and number of learning trial errors, (ρ = .69, p =.001). This

indicated that older participants took more time to complete the learning trial, tended to require more attempts and make more errors.

Friedman tests were used to examine changes in word-pair recall and duration to complete trials across the three time points (learning trial, 55-minute delay and 24-hour delay recall). A paired t-test was conducted to assess difference between 24-hour delay word-pair recall and recognition. Results are presented in Table 7.

Table 7
Descriptive statistics and analysis of performance across trials

	Mean Rank	Statistic	df	p	Effect Size
Word-pair recall					
Learning	3.00	$X^2 = 28.84$	2	<.001*	W = .90 (Large)
55-minute delay	1.66				
24-hour delay	1.34				
Duration to complete					
Learning	3.00	$X^2 = 30.13$	2	<.001*	W = .94 (Large)
55-minute delay	1.06				
24-hour delay	1.94				
24-hour delay					
Recall	M = 4.24 (SD= 3.17)	t = -6.55	15	<.001*	d= 1.66 (Large)
Recognition	M = 8.75 (SD= 2.11)				

* Statistically significant

The results showed a statistically significant effect of time and word-pair recall. The mean rank for the number of word-pairs learned at the learning trial was higher than the mean rank for word-pairs recalled during the 55-minute and 24- hour delays. This showed participant recall declined after the 55-minute and 24-hour delays.

The results showed a significant effect on duration of each trial. The mean ranks revealed participants took the longest amount of time to complete the learning trial, and the least amount of time completing the 55-minute delay. The mean rank for the 24-hour delayed recall increased though remained lower than the learning trial, showing participants took longer at this timepoint, but still less required more time to complete the learning trial.

The t-test showed that participants were able to recall more word pairs when provided with recognition cues, compared to recalling without any additional prompts after a 24-hour delay.

Wilcoxon signed-rank tests were conducted as post-hoc tests for the Friedman analyses. A Bonferroni correction (adjusted $p = .017$) was applied. There was a significant difference between the learning trial and 55-minute delay, ($z = -3.53$, $p = .001$, $r = -.88$), and learning trial and 24-hour delayed recall, ($z = -3.53$, $p = .001$ $r = -.88$), indicating large sized effects. However, there was no significant difference between recall at 55-minutes and 24-hours, ($z = -1.93$, $p = .053$, $r = -.48$).

Post hoc analyses showed that participants took more time to complete the learning trial compared to the 55-minute delay ($z = -3.52$, $p < .001$, $r = .88$) and 24-hour delay, ($z = -3.52$, $p < .001$, $r = .88$). Participants also took longer to complete the 24-delay recall test than the 55-minute delay, ($z = -3.64$, $p = < .001$, $r = .84$).

Discussion

This study examined online neuropsychological test performance over a two-year period in older adults with SCD, providing an insight into how cognition changes overtime within this group, using exclusively online testing platforms.

Overall, the findings demonstrated that scores on neuropsychological testing remained mostly unchanged overtime, except for faster completion time on the TMTA. CCI scores increased between 2023 and 2025, with all participants all scoring above the cut-off for SCD, indicating greater perception of cognitive decline. However, performance on neuropsychological testing within this group alone were not significantly different between baseline, six-month follow-up or follow-up in

2025. GDS significantly reduced between timepoints, suggesting decreased self-reported low mood. This finding contradicts other studies which link presence of depressive symptoms and increased cognitive complaints (Wereszczyński & Niedźwieńska 2021). Furthermore, increased reporting in depressive symptoms is associated with overreporting of cognitive complaints and functional impairment (Verrijp et al. (2022))

In terms of the interaction of self-reported low mood and impact on cognitive performance, Pietrzak et al. (2013) found that older adults with increased anxiety demonstrated clinically significant decline on neuropsychological tests over a two-year period. Whereas participants with depression demonstrated reduced performance on a reaction time task only. These findings appear to contradict the present study, where depression scores reduced between 2023 and 2025, and performance on one reaction time task (TMTA) improved.

It must be noted that the participants who undertook this study undertook previous testing and so practice effects may have influenced their scores, although a year had passed between 6-month follow-up and 2025 follow-up. Additionally, past involvement in Peterson et al. (2025) may indicate an increased awareness of cognition in this sample, as can be the case with this area of research (Verrijp et al., 2022).

With regards to performance on the VALMT, participants showed reduced word-pair recall at 55-minutes and 24-hour recall. However, they were able to correctly recognise word-pairs. These findings suggest that cues supported recall, particularly when the cue has been learned and consistently associated with the target item (Aue et al., 2012). Furthermore, all participants who undertook this test reported SCD. Their performance on the task was in-keeping with McGibbons et al. (2022) who found that healthy older adults with greater self-reported cognitive complaints demonstrated slower learning and recall of the word-pairs. Similarly, Jester et al. (2022) found that participants with SCD who demonstrated impairments on another list learning task (RAVLT, Rey, 1958), had greater risk of developing amnestic mild cognitive impairment. Therefore, specific language-based memory tasks may present an area of difficulty with the SCD cognitive profile.

Directions for future research should focus on larger cohorts of older-adults, with application of mixed-effects modelling approaches to further understand the trajectories within SCD. Additionally, use of ecologically valid measures pertaining to everyday cognitive functioning may assist in adding to the knowledge of self-perceived cognitive complaints and objective performance.

Limitations

This research demonstrated several strengths. The longitudinal design allowed to examination of neuropsychological test scores within the same cohort of older adults over the two-year period. Therefore, providing valuable insights into how SCD may present on testing over time, which is a strength of this research design (Caruana et al., 2015). Additionally, the study applied a validated measure, the CCI, to ascertain SCD which also explored perceived decline in more detail, rather than asking a Yes/No question around presence of perceived cognitive decline as outlined in the SCD-I criteria (Jessen et al., 2014),

However, there were several limitations. Of note, the sample did not meet statistical power, and therefore some analyses were conducted using non-parametric tests. The study aimed to recruit from a pool of participants who had completed previous neuropsychological testing at two-time points; baseline 2023 and six-month follow-up. Due to reduced uptake and recruitment issues, study invites were sent to participants who consented to be contacted regarding future research but had only completed baseline testing. Thus, limiting the six-month follow-up representation in the data.

With regards to the demographic of the sample, all identified as White British and therefore did not represent a diverse population. The majority had university level education, which may have influenced performance on neuropsychological tests.

The nature of online tests meant that participants could undertake the tasks at home, and not under supervision. Therefore, engagement and integrity of participation with the neuropsychological tests was not observed. Peterson et al. (2025) examined the test-retest validity of the battery using interclass correlation co-efficient, which revealed mixed (poor to very high) for the tests used within

participants with SCD. Furthermore, timeframe in which the ICC was conducted was six-months, with the test-retest validity for the same battery over the longer period not explored in this study.

Furthermore, the neuropsychological tests used in the study are novel and not used in clinical practice. Peterson et al. (2025) examined the test-retest reliability of the tests used in this study, however the results of this did not provide means, standard deviation or standardised errors of difference. Therefore, it was not possible to complete the Reliable Change Index (RCI, Jacobson & Truax, 1991).

Therefore, statistical tests for examining at group-level between timepoints were opted for to assess for changes in scores. However, this may have led to subtle changes in performance being missed, particularly in the absence of more detailed examination of the data using the RCI. Additionally, the use of non-parametric tests, while appropriate given assumption violations and size of the data, are based on ranking scores and therefore may have been less sensitive than parametric testing.

To ensure direct comparison with the above study, the same criteria for defining SCD based on the CCI was applied. The CCI has been evidenced to predict future decline (Nester et al., 2024), and utilising the cut-off score of 20, as recommended by the authors of the measure. However, this definition does not completely align with the definition of SCD in research as proposed by Jessen et al. (2014). Yet, Risacher et al. (2017) found that the CCI cut off of 20 on the first 12 items has been shown to be accurate for screening SCD, as was the purpose of this study.

To conclude, online neuropsychological tests may be a useful tool, for monitoring for SCD and future progression. Future research could focus on developing a cognitive profile of SCD with better understanding of its trajectory, as the current study highlights reasonably stable cognitive performance on a test battery over time, with verbal memory highlighted on a word-pair accelerated forgetting test. Furthermore, future research into personal reports of cognitive decline, particularly with additional physical health features may assist with developing assessment tools and spotting those at risk of further decline.

Disclosure of Interest

The authors report there are no competing interests to declare.

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CHAPTER FIVE: Bridging the Quantitative and Qualitative Empirical Papers

Previous research focusing on SCD has tended to be cross-sectional and quantitative, and therefore the voices and personal experiences of people living with SCD is less reflected in the research. The previous chapter presents a longitudinal research paper on a cohort of older adults living with SCD. However, this thesis portfolio also aimed to understand experiences of living with SCD via implementing a mixed-methods design, using content analysis for the qualitative aspect of the research.

It was felt that presenting participants' voices in the research was important given the lack of qualitative research within the SCD field. Furthermore, participants who completed an interview had also undertaken the neuropsychological testing involved in the previous study, therefore had volunteered significant time. The lead researcher felt that representing both aspects of the project as separate studies reflected participants' dedication and contribution to the research. Furthermore, by separating the project into two separate papers, the lead researcher was able to use the rich and detailed information participants provided during interviews. Additionally, it was decided that thematic analysis was more appropriate for analysing the data, and in-keeping with the research aims, providing more understanding the experiences of people with SCD.

CHAPTER SIX: A Thematic Analysis Exploring Personal Experiences of Subjective Cognitive Decline in Older Adults

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Abstract

Objective: Earlier detection and treatment of Alzheimer's disease (AD) has been a focus of NHS policies such as the Ten-Year Plan. Subjective cognitive decline (SCD), defined as self-reported cognitive deterioration without impairment on neuropsychological tests, may present as an earlier stage of objective cognitive decline, such as mild cognitive impairment (MCI) and AD. This thematic analysis aimed to develop understanding of how SCD is experienced by people and its everyday functional impact, and how individuals manage these. Focusing on this area will aid future assessments and support for people with SCD.

Method: Older adults (aged 60 and over) who had identified as having SCD based on the Cognitive Change Index (CCI), recruited from a previous research study, were invited to a semi-structured interview. The interview focused on exploring perceived cognitive changes, experiences and strategies used to cope. Interviews were analysed using reflexive thematic analysis.

Results: Ten participants completed an interview and four themes were developed: perceived cognitive decline, perceived physical health decline, focus on the future and strategies. Participants shared word-finding and attentional difficulties, though did not feel their autobiographical memory had declined. Emotional responses related to worries about the future and acceptance of age-related decline. Participants also shared compensatory strategies, as well as lifestyle adjustments applied to maintain cognitive health.

Conclusions: These findings contribute to understanding how SCD presents from a personal perspective, highlighting everyday functional impact and emotional responses. Results from this study may inform clinical practice for assessment of older adults reporting SCD.

Introduction

The UK has an aging population with Census data revealing the older adult population has risen from 8.3 million (14%) in 2001, to 9.2 million (16.4%) in 2011 and 11 million (18.6%) in 2021 (Office of National Statistics [ONS], 2001; ONS, 2011; ONS, 2021). This trend is predicted to continue. Age presents an increased risk for developing neurogenerative diseases, particularly dementia (Van der Flier & Scheltens, 2005; Hou et al., 2019).

Dementia is a progressive disease, causing gradual decline in cognitive skills and affect changes (Carr, 2017; Hobson, 2025). The term dementia is overarching and refers to a range of neurodegenerative conditions. Alzheimer's Disease (AD) is the most prevalent type of dementia globally (Alawode et al., 2022; Tahami-Monfared, 2022). In the UK, cases of AD are predicted to rise in-keeping with the aging population, with the Dementia UK report estimating cases of AD rising from one million in 2025 to two million by 2051 (Prince et al., 2014). Currently, AD is non-curable, though medications for symptom management may be effective with earlier diagnosis (Helaly et al., 2021; Rassmussen & Langerman, 2019). Therefore, earlier detection and prevention for AD have been prominent in NHS policy, with the NHS Ten-Year Plan (NHS England, 2019; 2025) pledging to prioritise new dementia therapies.

Symptoms of AD can take years to present, and therefore individuals may experience a phase of subtle cognitive changes without impaired performance on cognitive testing (Cedres et al., 2019; Jiwtode et al., 2021; Sperling et al., 2011; Rabin et al., 2017). The term subjective cognitive decline (SCD) pertains to such individuals and is defined by the SCD Initiative as self-reported cognitive complaints, without objective impairments (SCD-I; Jessen et al., 2014. The National Institute on Aging and Alzheimer's Association (NIA-AA; Jack et al., 2018) similarly describe a "Cognitively Unimpaired" stage within the AD continuum. This is defined as cognitively unimpaired individuals who report SCD, and/or may show subtle deterioration on repeated cognitive tests (Jack et al., 2018). Furthermore, approximately 50 – 80% of adults aged over 70 report SCD (Jessen et al., 2021), indicating the experience has a high prevalence in older adults.

Exploring personal experiences with SCD specifically is less researched. Buckley et al. (2015) conducted a literature review focusing on qualitative research which recruited healthy older adults, as well as people with diagnoses of mild cognitive impairment (MCI) and AD. Several key themes were identified around experiences of cognitive decline, including: changes to cognition (gradual decline on daily activities; cognitive symptoms; compensatory strategies), emotional impact (anxiety around actual or perceived change; fears of becoming a burden), changes to insight, attributing a cause (stress; illness; medication; normal aging) and wellbeing (strategies to maintain cognitive health; outlook on situation and negative perceptions of aging). The authors concluded that understanding phenomenological profiles of SCD, particularly given the association with AD, could assist with identifying individuals with an increased risk of developing dementia earlier.

The focus of this paper was to interview people from the earlier study who have SCD with the aim was to understand SCD from a lived perspective. As noted, people with SCD may not demonstrate objective impairment on neuropsychological testing and are more likely to seek medical help for their perceived cognitive changes (Jessen et al., 2014; 2020). Therefore, it is important to develop a clearer understanding of how individuals with SCD experience and describe changes to their cognition, along with the impact these have on their daily lives to inform future assessment practices.

Aims and Hypotheses

The present study aimed to gain an understanding of how SCD are experienced and reported by older adults who report living with cognitive changes. The focus was on how these individuals describe the changes they have noticed, and the language they use to interpret their experiences within their context and daily lives. Additionally, this study aims to understand who these individuals cope with the perceived changes, to offer insights into how people with SCD manage and navigate around their perceived cognitive decline.

. While no formal hypotheses were specified, theory, understanding and literature relating to SCD, such as the SCD-I definition (Jessen et al., 2014) were applied. The SCD-I (Jessen et al, (2014) outlines that people with SCD report mostly memory concerns, and so it was anticipated that participants would mention this in the interview. Therefore, the current understanding of SCD in the literature was used to inform the topic guide. Additionally, input of individuals with SCD, separate to the study population, was sought to assist in developing the topic guide.

Ethical Approval

This project received ethical approval from the University of East Anglia Faculty of Medicine and Health Science Research Ethics Subcommittee (ETH2425-2236). Participants provided informed consent via online consent forms.

Methods

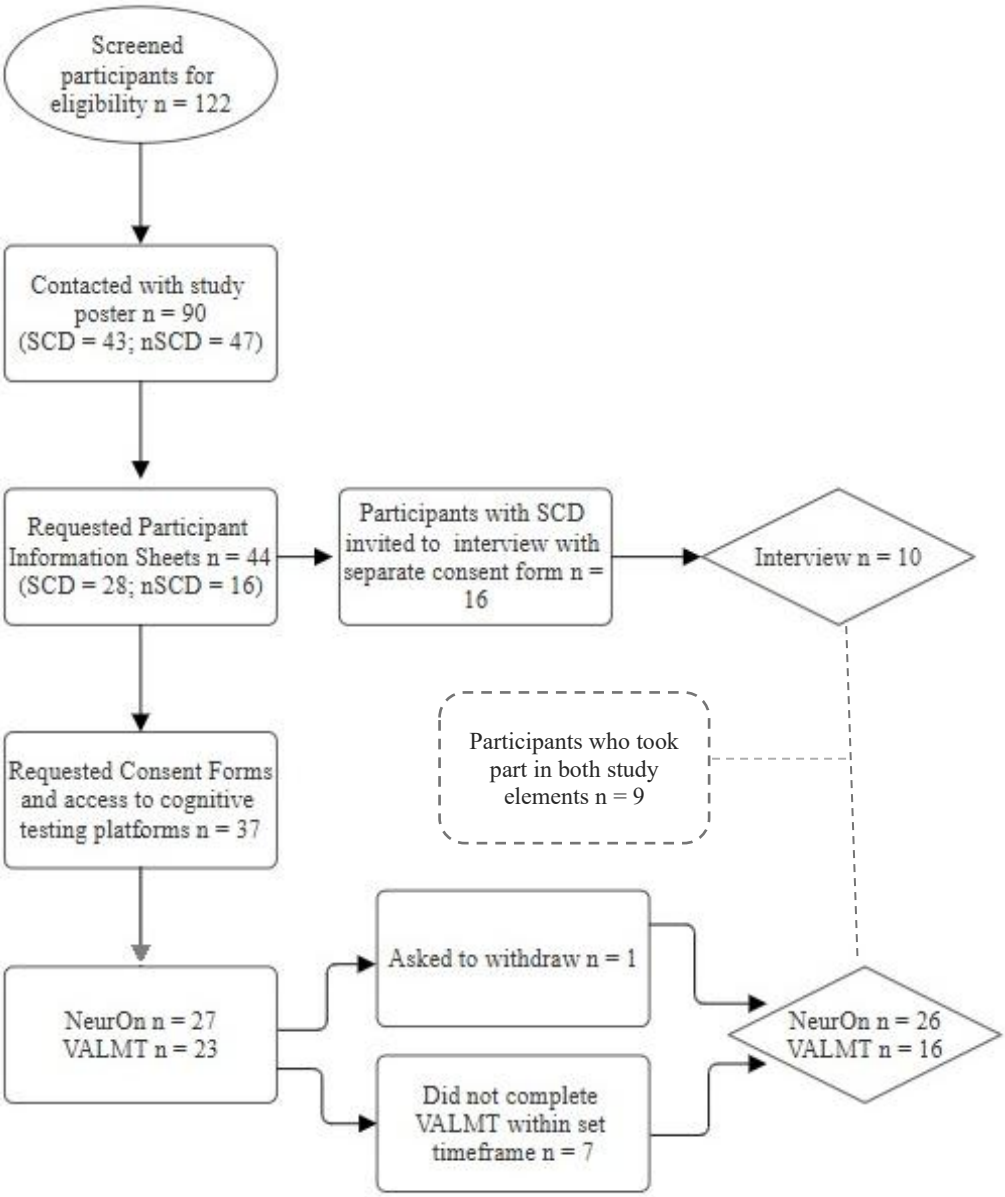
Participants

Recruitment started in January 2025, following obtaining ethical approval. Participants recruited for this study had also previously taken part in Peterson et al. (2025) study examining test to re-test reliability of online neuropsychological testing. As part of the consent process for the previous study (Peterson et al., (2025) participants were asked if they consented to be contacted in future for other relevant research projects. Two groups were established as part of this study; individuals who reported experiencing SCD and those who did not. Therefore, once the lead researcher was able to data for these participants, their original consent forms were checked. Those who reported having SCD in the original study and provided consent to be contacted regarding future research were provided with the research poster. The recruitment process is shown in Figure 1.

As this study was using interviews for data collection and reflexive thematic analysis, it was decided to aim to recruit 10-12 participants, to reduce data saturation (Ahmed, 2025; Guest et al., 2006).

Figure 1

Participant Recruitment flow diagram



Note. SCD = participants who reported subjective cognitive decline, nSCD = participants who did not report SCD within the Peterson et al (2025) study. Furthermore, this study was completed in-conjunction with an additional study examining SCD over a two-year period using online neuropsychological testing. Therefore, participants contacted regarding the interview were also

invited to take part in the neuropsychological testing study. Of the participants who undertook the interview, nine had taken part in both projects.

Topic guide

The topic guide was developed in collaboration with Patient and Public Involvement (PPI). Four adults aged over 60 who identified as having SCD with no other neurodegenerative conditions, spoke individually with the lead researcher via a phone call. From these conversations, the individuals informed the interview questions by sharing their personal experiences. These conversations identified areas that they felt they had noticed more change to their cognition, including word finding difficulties for names and difficulties sustaining concentration on tasks such as reading or holding a conversation. Furthermore, the individuals presented areas they felt were pertinent to the research aims, such as inclusion of pain and health questions in the interviews. Feedback was also provided pertaining to language and phrasing of questions and if they would feel comfortable being asked such questions.

Data Collections

Participants who reported having SCD in the Peterson et al. (2025) study were contacted with the study poster and those who expressed interest were sent the Participant Information Sheet (PIS). This was followed by the online consent form, upon request. Once consent forms were signed, individuals were contacted to arrange a time to meet via Microsoft Teams. Phone calls were offered if this was established as a preference for participants.

Interviews were 45 – 60 minutes in duration, following the topic guide. As part of the topic guide, participants were given space at the end of the interview to ask any of their own questions. Additionally, time was allocated for debriefing.

Microsoft Teams Transcription software was used to transcribe the interviews and was reviewed by the lead researcher afterwards for accuracy.

Analysis Plan

Data collected was analysed using theoretically informed semantic reflexive thematic analysis, to identify patterns across interviews and develop themes within the data. The six phases outlined in Braun & Clarke (2006) were followed throughout. This approach was selected as the study aims were to understand personal experiences of SCD from the lens of the participants, thus aligning with reflexive thematic analysis approaches (Braun & Clarke, 2006).

A theoretically informed approach was applied given that SCD has been defined in research by the SCD-I (Jessen et al., 2014). Furthermore, SCD literature outlines cognitive domains associated with SCD complaints including episodic memory, attentional difficulties, language impairment and changes to visuospatial and executive functioning skills (Ahn et al., 2021; Si et al., 2020; Valech et al., 2017). Each of these areas were included in the topic guide, as well as informed by the PPI engagement, and provided a theoretical lens during data coding. However, in-keeping with reflexive thematic analysis, the researcher remained open to patterns and themes outside of the SCD-I definition and previous literature, allowing for other experiences participants described in relation to SCD to be included in analysis. A semantic level of analysis was conducted, in line with the research aim of understanding changes individuals with SCD experience, how they report these, and the day-to-day impact noted by the individual.

Philosophical Considerations

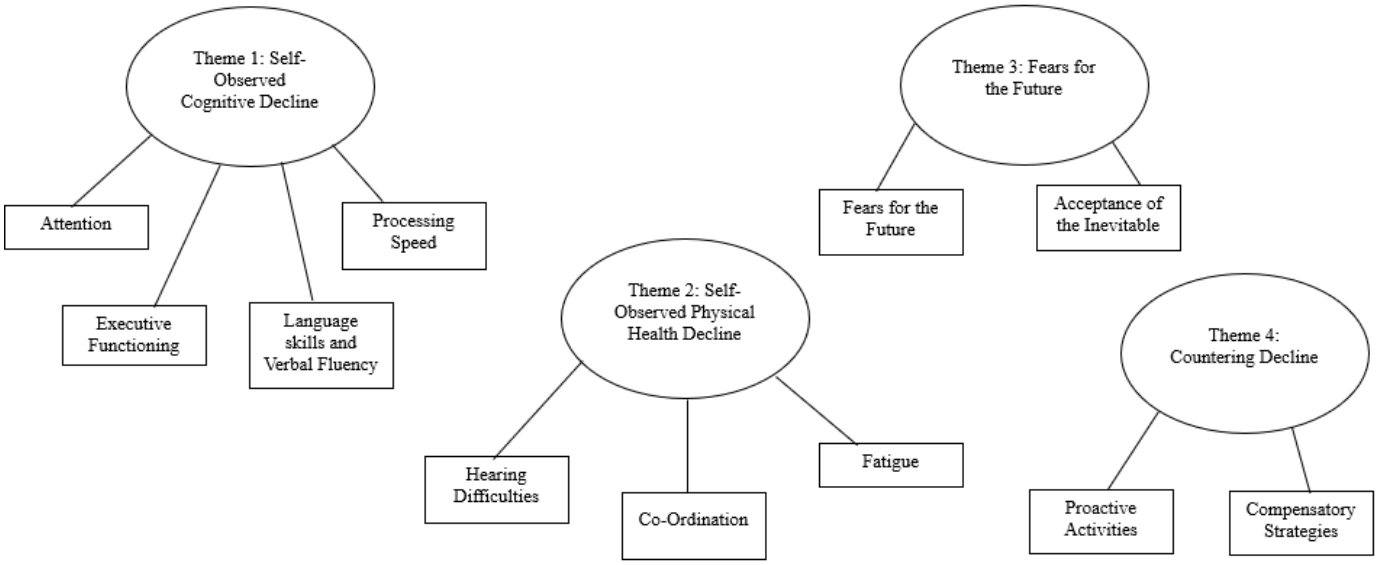
This study was conducted within a critical realist lens, recognising that participants' accounts of SCD reflect their realities, while acknowledging that individuals experience pertaining to SCD will differ based on personal, social and contextual factors. This approach aligns with reflexive thematic analysis and emphasises the researcher's role and influence on interpreting and engaging with the data (Ahmed et al., 2025; Braun & Clarke, 2006).

Results

A total of 10 participants within the original-SCD group completed an interview with the lead researcher to explore their experiences of SCD. Of this group, three were female, and seven males. From this, four main themes were identified (Figure 2).

Figure 2

Themes and subthemes identified from the reflexive thematic analysis



Theme One: Self-Observed Cognitive Decline

Participants described changes they have noticed in their cognitive skills and cited the impact these have on their day-to-day functioning. Under this theme were four sub-themes: attention and multi-tasking, language and fluency, processing speed and executive functioning. This theme reflected participants' interpretation of memory covering multiple cognitive domains and feeling less confident in their abilities resulting from perceived decline.

Attention (working memory). These experiences were typically described as "short-term memory" or a general "forgetfulness" and pertained to attentional difficulties. The term attention was considered in line with the Baddeley (2000) model for attention and working memory. This model explores attention and working memory as the ability to hold information in mind for a short amount of time, usually seconds. The experiences described by participants related to entering a room and

forgetting why, or losing items around the house, which requires the use of attention and working memory, to hold in mind the goal-directed behaviour (e.g. reason to going into a room) and the item the person was looking for. Therefore, participant reports of losing track of information they were holding in mind in that moment was felt to be related to attention and working memory, more so than memory for events and personal memories.

"I will think I must go and get something by the time I've walked through the door; I've forgotten what I was going to do". (Participant 2).

"I'll just to walk into a room to go and pick something up. And I'll start off in the kitchen, get to the living room and then 'Why did I come in here?'" (Participant 6)

"I mean like, like things like leaving the keys in the wrong part of the house" (Participant 3).

"My glasses are the worst thing. I put them down. I think. Where did I put them? And I'm running everywhere, looking at my phone, I lose my phone constantly. A nightmare." (Participant 5).

"I needed my glasses for watching TV and I knew they were upstairs on my bedside table. But by the time I got upstairs, I couldn't remember what I'd gone up for and immediately remember when I sat down again". (Participant 9).

"*I can't hold numbers in my head like I used to […] I used to have eight chickens. I'm down to five now, but I could just look at eight chickens and know there's eight chickens there. But now I have to actually count them and keep restarting because I lose count"* (Participant 1).

Overall, this subtheme related to difficulties holding information in mind for short periods of time. While participants tended to describe these experiences as memory related, the examples they gave related to undertaking every-day goal directed behaviours and were more in-keeping with attention and working-memory lapses.

Executive Functioning. Participants cited perceived changes to their executive functioning, particularly in terms of feeling less confident using technology, as well as difficulties with problem solving and multi-tasking.

"But I did notice a couple of weeks ago when something went horribly wrong on my computer. I know 20 years ago I'd have been able to sort it on my computer. Much to my annoyance I had to take it into the shop" (Participant 9).

"We have a gadget and an app for everything, Octopus for the heating, the hot water and I dare not touch it." (Participant 10).

"I can reason problems out. That's no problem, as long as I'm only doing one at once" (Participant 1).

"We talked to thinking about changing our battery so you know I'm looking at that whole variety of issues associated with battery fittings and design and the like and yes, so a lot of balls in the air [...] But I just think it is of where perhaps yes, multitasking aspects start to get slightly less easy to manage" (Participant 8).

This subtheme indicated that participants notice a subtle decline in their confidence and ability to use technology, even if they noted once being able to use computers well in the past. Furthermore, participants described needing additional time and concentration to manage one problem at a time. Collectively, this suggests that their executive functioning and problem-solving skills remain, but may be difficult to apply if multi-tasking,

Language Skills and Verbal Fluency. Participants also shared changes to their language, typically described as "forgetting words" or "forgetting names".

"You're talking certainly can't get the words. Yeah. Yeah. It's almost. It's in your brain somewhere and you just can't bring it down." (Participant 1).

"I just couldn't think what it was called. And several times I thought, why can't I just think of what it's called and different names of things? Sometimes I just seem to not be able to recall something specific, and eventually it does come back" (Participant 5).

"There is the occasional time when I'm discussing something and a particular word or need of something […] the word I want to say, I just can't […] It just goes missing. It's there, it will come back to you. Perhaps like hours after the conversation and you'll think. Oh, yes, that's what I was trying to say earlier." (Participant 6).

"That's another thing I struggle to remember words for things." (Participant 7).

"Yeah, you can see [the person] in your mind. And you recall that when they come back to you later. Effortlessly, seemingly. But I can't remember that person's name." (Participant 8).

While participants reported that word-finding difficulties usually returned, collectively, they reported to struggling to recall words in the moment, and these returning spontaneously after a delay. Therefore, this possibly reflects that SCD can impact speech in the moment, however when conscious focus is shifted off finding the target word, it can return. Therefore, it is possible participants perceive this as a temporary word recall issue, rather than a permanent loss.

Processing Speed. Participants described that they feel their thinking speed and reaction times had reduced, which was described as feeling "slower". During the interviews, participants related this feeling to both their cognitive and physical abilities.

"I'm definitely not as fast in some general sense now […] And I just don't have the sort of the thinking power that I used to […] I play tennis every week. You know, I don't play as well as I used to. […] Do I think my reactions are much slower? Definitely." (Participant 2).

"Maybe when you get into your 70s and you start to lose that sharpness, there you are. There's a description I'll take. I've lost some of my sharpness […] The ability to whether it's a comment or a situation or whatever the ability to take in and process and respond appropriately […] I

am definitely slower in reacting to the changing situations and this is now down to a physical thing, […] something will happen and I'm slower to react than I would have been before." (Participant 4).

"Now, I feel I am slower to recall key bits of information. I would say it is still there, but it takes time to come." (Participant 9).

Overall, participants described feeling "slower" and attributed this to their age. This may reflect a general view of getting older with losing one's ability to be as physically and mentally active with age.

Theme Two: Self- Observed Physical Decline

This theme relates to participants perceived decline in their physical health, and how this can impact their cognition. The focus was placed on hearing difficulties, changes to co-ordination and fatigue. This theme reflected participants experiences of aging, and the current difficulties they experienced.

Hearing Difficulties. Participants described how following conversations was harder with hearing difficulties and thus impacted their abilities to follow conversations, or need information repeated.

"I've got terrible tinnitus. So, the reason I couldn't follow anything would be because of the tinnitus" (Participant 1).

"I think part of my problem is that I had hearing aids. And quite often I can't hear what she's [partner] saying properly, so I have to ask her again" (Participant 3).

"I'm losing my hearing into my 70s and 80s. And I worry about the increased risk of dementia with these things" (Participant 10).

Collectively, participants shared how their hearing loss impacts their ability to attend and follow conversations. However, there is also suggestion of anxiety around the potential link between hearing loss and cognitive decline. This possibly reflects that participants link their physical health to their cognitive health with possible concerns that decline in one may lead to decline in the other,

Co-Ordination. Participants also noted changes to co-ordination described as balance or "clumsiness".

"I'm definitely having problems with walking […] I feel as though I've lost my balance, but I haven't. I'm standing straight upright, so it's not that I'm falling over. It's just that I feel I'm falling over." (Participant 1).

"There are times when I felt slightly clumsier. I'm always being told I'd break more cups than anybody else." (Participant 8).

"Don't know about my co-ordination, but I do know my balance is not what it should be, I used to play golf, I want to get back and play again, but there's various issues about standing on one leg and so on that would be too hard. No, my balance just wouldn't have it." (Participant 9).

Collectively, participants described feeling less co-ordinated and the impact this has on their day-to-day activities. These were reflected as feeling less balanced or more clumsy undertaking tasks they did not report issues within the past. Therefore, this possibly suggests participants have an awareness of subtle, physical health changes associated with aging.

Fatigue. Participants described the impact tiredness has on concentration heavy tasks, as well as a lack of energy in general.

"I mean, get getting out straight out of bed and doing something important. It's definitely a no; I tend to wait till I'm more fully awake before I tackle things." (Participant 7).

"You don't just feel physically rested, but your brain definitely feels, you know, subpar." (Participant 8)

"Well, I feel I don't take information in as well. It is much harder to take everything in when I am tired" (Participant 10).

Overall, this subtheme related to physical tiredness and this impact participants perceived this to have on their cognitive abilities. Collectively, this may reflect that participants view themselves as being less sharp cognitively and attribute this fatigue and increased need for rest.

Theme Three: Focus on the Future

The third theme related to thoughts around the future, and ongoing cognitive and physical health decline, and the emotional impact this had. Participants also described a sense of acceptance of the inevitable. This theme reflected a perception of ageing held by participants, leaning on their understanding of continued cognitive and physical decline.

Fears for the Future. Participants described a sense of worry about the future.

"I find that quite disturbing because in the past my memory has been such a - it's been like the rising and the setting of the sun. It's something I could absolutely rely on." (Participant 4).

"Because I have two friends I see with dementia […] and it's something that I would absolutely dread." (Participant 9).

"Oh, I would say I worry a lot about the future. My father died when he was 74 [of dementia] , and my mum from cancer at 66" (Participant 10).

Overall, this subtheme reflected that participants are very aware of their perceived changes to their cognition and are also aware that those within their age group may be diagnosed with dementia

too, Therefore, this may reflect an increased sense of anxiety around not only the future, but the cognitive changes the participants are noticing.

Acceptance of the Inevitable. Participants described was a sense of acceptance of inevitability of needing care, and aging.

"You know, if my memory gets worse, then I've got to cope with it. I keep warning my son and I've got a daughter who lives in [Location] as well. And I keep saying to them, you know, if I get worse, you'll just have to put me in a home". (Participant 1).

"Obviously getting my age, you don't know how you're going to, whether you're going to get in a home […] I've got a big enough place for someone to stay and look after me." (Participant 3).

"I mean, I'm 70, so I feel inevitably there is going to be some degradation. And if that's the worst, it is going to have to do bloody well, I'd best just get on with it." (Participant 9).

In contrast to the subtheme above, this reflects that some participants had a sense of acceptance around the aging process. Therefore, they have taken the future into consideration and made steps around arranging care. Collectively, this may reflect a sense of acceptance around aging and taking a pragmatic approach to cope.

Theme Four: Countering Decline

The final theme focused on strategies participants described to "protect" their cognition and compensatory strategies used to navigate day-to-day with perceived cognitive difficulties. This theme reflected an understanding that the brain health can be "trained" with efforts from the individual.

Protective Activities. Participants described using crosswords and puzzles as a means of "testing" and maintaining cognitive function.

"We [partner] also do the crosswords and Sudoku together. It's like a way of keeping up with these things, keeping the thinking going" (Participant 9).

"Well, I like to test my memory and do as many crosswords and word puzzles as I can. Or Jigsaws. I try new puzzles to keep my brain learning, to challenge it more" (Participant 10).

Overall, this theme presents a sense of participants taking active steps to support brain health, while also undertaking tasks that they find enjoyable and social, for example including their partner. This possibly reflects the view from participants to need to "test" their cognitive skills and effortfully act to retain them.

Compensatory Strategies. Participants also shared memory strategies they have been using to support their memory. The most frequent examples related to keeping lists and relying on phone calendars with reminders.

"I'm very big on I've always been big on lists and [...] then I have a calendar and every day the calendar sends me an e-mail" (Participant 2).

"What I'm having to do if I can remember to do it, if I have a thought, I scribble it down on a piece of paper because I can get back to it." (Participant 4).

"But if I hadn't written down, I wouldn't have done it [..] would have said the last six months I'm relying a lot more on list making" (Participant 4).

"Like the event on the calendar - is check into EasyJet. And sort out car hire and other like. Obviously, you need to do that, but if I didn't specifically write it down, it would be very, very easy to forget that it needs to be done" (Participant 8).

Collectively, this theme highlighted that participants report the need to apply extra strategies to support with their perceived cognitive concerns. This may reflect a perception that they need to adapt to their current level of functioning and make use of external memory aids to support with their day-to-day functioning.

Overall, themes pertained to everyday functioning impacted by perceived physical and mental health decline, with examples mostly in-keeping with attentional difficulties. Participants also shared a range of emotional reactions from acceptance to worry about the future; alongside strategies they have developed to cope with cognitive changes.

Discussion

This study also aimed to understand SCD from personal experiences and add to the existing literature. Four main themes were identified from the interviews; self-observed cognitive decline, self-observed physical decline, focus on the future and countering decline. Overall, these themes collectively demonstrate how participants reported their perceived cognitive decline and how they made sense of these in terms of their understanding of aging, dementia and expected future decline.

The theme of observed cognitive decline can be understood when considering literature noting that individuals with SCD cite memory concerns (Cappa et al., 2024; Jessen et al., 2014; Wasef et al., 2021). However, participants mostly cited concerns which were related to executive, attentional and processing speed functions, and did not describe changes to their autobiographical memories, the ability to recall events pertinent to the individual from across their lifetime. During the interviews nearly all participants described their occupational backgrounds in rich detail, though their accounts were not examined for accuracy. Reports of autobiographical memory changes are noted to be in-keeping with mild cognitive impairment and early stages of cognitive decline (Bruus et al., 2021). Therefore, this study indicates that although memory concerns may be reported, people with SCD may notice attentional, word-finding and executive functioning difficulties in the first instance and interpret these as memory decline. Further to this, these experiences cause a sense of worry relating between fears of further decline, which results in an attentional bias to perceived cognitive difficulties, thus creating a negatively reinforced cycle of observed perceived decline and increased worry (Hill et al., 2019).

Maruta and Martins (2019) note that older adults with SCD cite language difficulties and showed a performance decline on verbal tests over a five-year period. The authors argue that verbal and semantic fluency tests by nature incorporate other cognitive functions, such as executive functioning and processing speed. Therefore, the cognitive related complaints participants reported in this study support literature around perceived cognitive decline.

Overall, this theme is in-keeping with the SCD-Initiative definition of SCD, which notes that perceived decline may involve any cognitive domain. Whereas increased concerns relating to perceived memory decline may indicate SCD-plus (Jessen et al., 2014).

The theme of observed physical decline is also supported by the literature that people with SCD also report reduced physical health (Pavel et al., 2023). Park et al. (2023) found that participants with SCD and bilateral hearing loss performed worse on the Stroop task compared to the healthy control group. While performance was only poorer on this one executive functioning task, the findings suggest that hearing loss may have an impact on cognition, as outlined by participants.

Additionally, some participants also reported changes to their balance and co-ordination. Motor-Cognitive Risk (MCR) Syndrome relates to changes in gait, slower walking and presence of SCD, and is associated with increased risk of developing dementia (Ayers, Wang & Verghese, 2022; Meiner, Ayers & Verghese, 2020). Therefore, participants experience of perceived decline in their co-ordination and balance may reflect a physical-health element to SCD, alongside cognitive concerns.

Mental fatigue has also been found to link with reports of SCD in older adults (Pavel et al., 2023; Zhang et al., 2023). Factors such as difficulty completing tasks, lack of energy, sleeping more and poor task performance which are indicators of mental fatigue (Zhang et al., 2023) were cited by participants during interviews.

The focus of self-observed physical health decline within the participants associated cognitive concerns may be linked. Participants described feeling “slower” when fatigued, and increased effort to follow conversations due to hearing decline. Therefore, these may reflect that participants experienced increased cognitive load when undertaking tasks which involved the domains they reported decline in

(attention, processing speed, word-finding and multi-tasking). Increased awareness of perceived physical health decline presented alongside perceived cognitive decline.

The theme of fears for the future relates to participants expressing concerns around further decline, and others accepting they may eventually need care. Both of which present different attitudes around the future, with some participants highlighting that they are using the present to prepare for the future. This theme aligns to literature exploring attitudes towards aging in non-clinical older adult population, with a range of themes from apprehension, concerns of decline alongside a positive attitude, or taking proactive steps such as discussing future care, writing wills and arranging funeral plans (Clarke & Warren, 2007; Elliot & Carpentieri, 2020; Wright & Lovatt, 2024).

This final theme focused on strategies participants shared that they use to either preserve cognition or manage with perceived changes. The notion that brain health can be maintained or improved using methods such as crosswords or sudoku has been explored in the literature, with adults across age groups supporting the belief that such activities offer cognitive benefits (Bowes, et al., 2012; Hosking et al., 2015).

The memory strategies participants described, such as keeping lists and calendars with alerts aligns with research which indicates older adults with SCD are more likely to implement compensatory strategies (Frankenmolen et al., 2016). Furthermore, the use of the strategies described (i.e. external memory aids) increases with age (Bouazzaoui et al., 2010) and is in-keeping with what participants shared.

Limitations

This research had several limitations. With regards to the demographic of the sample, all identified as White British and therefore did not represent a diverse population. The majority had also attended university level, which may have influenced their understanding of their cognitive function. Seven of the participants were male and therefore may share a very different experience of cognitive

decline to females. Especially during and post-menopause and experiences of brain fog within these life stages (Maki & Jaff, 2022).

Conclusions

Interviews with participants with SCD revealed shared experiences of change, such as increased attentional, word-finding, executive functioning and balance difficulties. This highlights potential areas to consider in clinical settings when working with individuals with SCD. While definitions of SCD focus on self-reported memory complaints perceived only by the individual, the interviews revealed certain experiences within SCD were shared. Thus, this information contributes to further understanding and profiling SCD more clearly. Furthermore, while the main concern with SCD pertains to cognitive decline, participants also reported the impact of perceived physical health decline on their cognitive abilities. Examples they described related to hearing loss and extra effort applied to following conversations. Participants shared increased fears of hearing loss being linked to further cognitive decline. Therefore, such factors are important for the consideration of defining SCD. While cognitive complaints are the most notable aspect of SCD, physical health and the impact this has on individual's mental health, such as worry, may present with SCD too. Additionally, to manage with perceived decline, individuals with SCD may apply strategies they believe may delay or counter the cognitive decline. These may serve to mask cognitive concerns, without addressing anxieties or impact on mental health.

Therefore, findings from this study could be considered for assessment and cognitive rehabilitation and emotional support for people experiencing SCD. Further research into understanding individuals experience of SCD, exclusive to MCI and AD could also support in further developing understanding of SCD.

Disclosure of Interest

The authors report there are no competing interests to declare.

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CHAPTER SEVEN: Extended Quantitative Methods and Results

Extended Methods

NeurOn and Mantal Software Platforms

An application programming interface (API) allowed for the two systems to be integrated, which participants accessed via a login. This was established as part of the previous study (Peterson et al., 2025). From this, the research team were able to select the required neuropsychological tests to be completed, and directly link participants test scores from previous sessions.

The Verbal Associative Learning and Memory Test

Participants accessed the test via www.forgettingtest.org/valmt55m. The landing page for this website is linked to the present study as per the suffix of "valmt55m" and managed by the developers of the measure. When participants accessed the test, they were issued with case-sensitive code unique to them. They then used this to access the site again to complete the delayed trials. Participants shared their code via email with the lead researcher, who contacted the developers of the measure to obtain the data.

Extended Analysis Plan

Research Question One

Related t-tests have been shown to be robust against presence of outliers, particularly if the data is symmetrical (Jennings et al., 2002). However, when the data is skewed, as was the case, the t-test is undermined. Windorising was considered to address this issue, however this can increase risk of creating bias within the data (Wicker, 2025). Certain participants were present as outliers across both timepoints on different tests. This may have reflected cognitive variability within the sample. Windsorising these may have influenced the results and reduced the representation of differences on performance overtime. Therefore, no adjustments were made to ensure the data accurately reflected

the range of performance on neuropsychological testing, and non-parametric tests were applied on variables that did not meet parametric assumptions.

Furthermore, the main chapter focused on the neuropsychological test performance of the overall sample between baseline in 2023 and follow-up in 2025. In this extended chapter, results for neuropsychological testing results between 2023 and 2025 are examined for the participants within the previous study who reported having SCD in 2023, referred to as to the "original-SCD" (O-SCD) group.

Research Question Two

As described in the empirical paper, a Freidman's test was used due to a smaller sample size with assumption violations which could undermine a repeated-measures one-way ANOVA (Stoltzfus, 2016).

However, a potential limitation of the Freidman test is that it has lower statistical power compared to a repeated-measures ANOVA and operates by ranking data (Stojanović et al., 2018; Zimmerman & Zumbo, 1993). This method of analysis is also less related to the research question which focuses on how participant test scores change overtime, rather than ranking scores and exploring for differences. Thus, the Freidman test was opted for to ensure correct practice in statistical test section, but exploration of research question two using a repeated-measures ANOVA is included in this extended analysis chapter, given there was also rationale for using this.

Additionally, this chapter presents a 2x3 ANOVA used to further explore changes to neuropsychological testing across the new-SCD (N-SCD) and O-SCD groups across the three time points (baseline 2023, 6-month follow-up and 2025 follow-up).

Extended Results

Research Question One: Extra Analysis of O-SCD Baseline and Follow-Up 2025

A total of 14 participants were in the O-SCD group. Prior to analysing their testing scores for change, assumption testing was completed. This revealed certain subtests did not meet normality assumptions. While paired tests are considered robust against assumption violations (Jennings et al., 2002), non-parametric tests were conducted for the non-normal variables, to ensure consistency within this thesis portfolio. Table1 displays the results.

Overall, the CCI showed a significant increase in scores, indicating participants reporting higher rates of cognitive change. On testing, the Sustained Attention to Response Too Soon and Anticipatory Errors increased significantly, indicating reduced performance and rule following on this task, as errors are scored based on rate of reaction clicks to stimuli that are not feasible should the rules of the task be applied correctly. Participants also demonstrated significant improvement to time taken to complete the Trail Making Task A, demonstrated by faster completion on this task.

Table 1

Cognitive test results between 2023 baseline and 2025-follow up for the Original SCD group

Measure	Baseline 2023	Follow-Up 2025	Test Statistic	p	Effect size
Geriatric Depression Scale	*M* = 2.57 (2.21)	*M* = 1.71 (1.27)	*t*(13) = 1.64	.06	*d* = .44 (medium)
Geriatric Anxiety Scale	Mdn = 1.0	Mdn = .50	*z* = -1.44	.15	*r* = -.39 (medium)
Cognitive Change Index	*M* = 23.71 (5.99)	*M* = 33.93 (10.37)	*t*(13) = 4.75	<.001*	*d* = -1.27 (large)
Simple Reaction Task (ms)	*Mdn* = 361.28	*Mdn* = 332.30	*z* = -.66	.51	*r* = -.18 (small)
Digit Span Backwards N Correct	*M* = 5.69 (5.02)	*M* = 6.15 (4.56)	*t*(12) = -.41	.35	*d* = -.11 (very small)
Digit Span Backwards Longest Span	*M* = 4.23 (3.27)	*M* = 4.62 (2.79)	*t*(12) = -.49	.32	*d* =.-.14 (very small)
Picture Recognition N Correct	Mdn = 28.0	Mdn = 28.50	*z* = -.82	.42	*r* = -.23 (small)
Picture Recognition Correct Position	Mdn = 13.0	Mdn = 12.50	z = .36	.72	*r* = .09 (very small)
Sustained Attention to Response Average Time (ms)	*Mdn* = 262.53	*Mdn* = 370.10	z = .87	.38	*r* = -.24 (small)
Sustained Attention to Response Average Time errors	*M* = 95.31 (66.76)	*M* = 110.62 (63.78)	*t*(12) = 1.79	.05*	*d* = -.50 (medium)
Word Recognition N Correct	*M* = 23.54 (3.05)	*M* = 23.15 (4.49)	*t*(12) = .32	.37	*d* = .09 (small)
Word Recognition Correct Position	*M* = 6.77 (3.72)	*M* = 7.54 (3.77)	*t*(12) = -.79	.22	*d* = -.22 (small)
Trail Making Test A completion Time	*M* = 34525.32 (10741.89)	*M* = 26924.28 (11222.16)	*t*(12) = 1.89	.04*	*d* = .53 (medium)
Trail Making Test B Completion Time	*Mdn* = 41964.91	*Mdn* = 35855.21	z = -31	.75	*r* = -..09 (very small)

* Statistically significant

Research Question Two: Further Analyses (Parametric Testing by Repeated-Measures One-Way ANOVA)

A repeated measures one-way ANOVA was used to examine changes to performance on neuropsychological testing across the three timepoints; baseline, follow-up (six +/- one month from baseline) and 2025. Assumption testing was completed for normality (Shapiro-wilk) across all three time points, as well as sphericity (Mauchly's test).

Normality was violated for SRT Incorrect (all timepoints), DS Incorrect (baseline), PR correct responses and false alarms (all timepoints), SAR average time (2025 only), WR False Alarms (baseline only) TMTA and TMTB errors (all timepoints), TMTB completion time (2025 only). However, the ANOVA was decided upon due to most of the data meeting normality. Furthermore, ANOVAs and the *F* statistic is considered robust against normality violations (Knief, & Forstmeier, 2021; Troncoso-Skidmore & Thompson, 2012).

The assumption of sphericity was not met for SRT N Incorrect, WR N Correct, TMTB errors and time to complete. Therefore, degrees of freedom and *F*-ratio were adjusted using the Greenhouse-Geisser statistic. The non-parametric equivalent (Friedman test) was utilised for the analysis in the main paper in the interests of adhering to correct procedures when data does not meet parametric assumptions. However, a potential limitation of the Freidman test is that it has lower statistical power compared to a repeated-measures ANOVA and operates by ranking data rather than examining for changes (Stojanović et al., 2018; Zimmerman & Zumbo, 1993).

A full summary of the analyses for all the aspects of the neuropsychological tests is shown in Table 2. The only test which showed a significant main effect on time was the SRT reaction speed, $F(2, 20) = 4.28$, $p = .03$, $\eta_p^2 = 0.30$ indicating a small sized effect. All the other tests were non-significant. Post hoc pairwise comparisons indicated baseline scores were significantly slower than follow-up scores (mean difference = 36.09ms, $p = .02$), though baseline to 2025, and follow-up to 2025 were not significantly different. However, when Bonferroni corrected pairwise comparisons

(adjusted $p < .05$) were applied, there were no observed significant differences between the timepoints on this task.

Therefore, while the main effect of time was significant, indicating that participant performance did differ over time, lack of significant pairwise comparisons suggest there is no distinct differences in performance across the three timepoints.

Table 2

Analyses of Repeated Testing for the "New-SCD" Group

Measure	Mean	SD	F(df)	p	η_p^2
Simple Reaction Time (SRT) Average					
Reaction Speed					
Baseline	317.80ms	59.02ms	4.28		
Follow-up	353.88ms	63.87ms	(2, 20)	.03*	.30
2025	347.83ms	64.81ms			
N Incorrect					
Baseline	.73	2.10	0.59		
Follow-up	.64	2.11	(1.03, 10.28)	.47	.06
2025	.18	.41			
Digit Span Backwards (DS)					
N Correct					
Baseline	6.40	5.06	2.02	.16	.18
Follow-up	6.00	4.52	(2, 18)		
2025	8.90	4.46			
N Incorrect					
Baseline	2.60	.70	2.16	.14	.19
Follow-up	3.20	1.40	(2,18)		
2025	2.10	1.23			
Longest Span					
Baseline	4.60	3.03	1.60	.23	.15
Follow-up	4.40	2.88	(2, 18)		
2025	6.30	2.67			
Picture Recognition (PR)					
N Correct					
Baseline	28.10	1.66	2.81	.09	.24
Follow-up	29.10	1.29	(2, 18)		
2025	28.10	1.37			

False Alarms					
Baseline	.50	.71	.08	.92	.01
Follow-up	.40	.70	(2, 18)		
2025	.50	0.53			
N Correct Position					
Baseline	11.90	2.28	2.66	.10	.23
Follow-up	12.90	2.28	(2, 18)		
2025	11.30	2.26			
Sustained Attention to Response Task (SAR)					
N Correct					
Baseline					
Follow-up	95.70	44.90	.19	.83	.02
2025	89.10	42.43	(2, 18)		
Anticipatory and Too soon	95.10	54.44			
Errors					
Baseline	118.90	53.71	.63	.55	.07
Follow-up	129.90	46.68	(2, 18)		
2025	120.70	50.68			
Average Reaction Speed					
Baseline	296.92ms	154.23ms	2.74	.09	.23
Follow-up	235.38ms	86.24ms	(2, 18)		
2025	306.07ms	83.93ms			
Word Recognition (WR)					
N correct					
Baseline	26.20	2.44	1.94	.19	.18
Follow-up	25.10	3.21	(1.15, 10.38)		
2025	24.30	3.27			
N False Alarms			1.53		
Baseline	.90	1.29	(2, 18)	.24	.15
Follow-up	2.10	1.73			
2025	1.60	2.07			
N Correct Position			.58		
Baseline	8.60	3.66	(2, 18)	.57	.06
Follow-up	7.90	4.01			

2025	8.90	3.11			
Trail Making Test A (TMTA)					
Completion Time					
Baseline	29076.66ms	7011.26ms	1.55	.24	.16
Follow-up	30806.44ms	8548.44ms	(2, 16)		
2025	26322.94ms	10004.20ms			
Errors					
Baseline	.56	.88	1.91	.33	.13
Follow-up	1.00	1.11	(2, 16)		
2025	.44	1.01			
Trail Making Test B (TMTB)					
Completion Time					
Baseline	41661.00ms	14243.15ms	.27	.66	.03
Follow-up	41655.64ms	11811.48ms	(1.20, 9.60)		
2025	39822.66ms	11026.70ms			
Errors			1.30		
Baseline	2.33	5.24	(1.06, 8.45)	.29	.14
Follow-up	.22	.67			
2025	.33	0.71			

* Statistically significant

Research Question Two: Further analysis across groups and time (2x3 ANOVA)

Due to the sample size not meeting power for a MANOVA, a mixed 2x3 ANOVA was used to analyse changes to the means of the neuropsychological tests across three timepoints (baseline, follow-up [6+/- 1 one month from baseline] and 2025) to examine differences between the two groups overtime. Participants who reported experiencing SCD in the previous study are referred to as "Original-SCD" group, whereas the participants who did not report SCD previously, though now score above cut-off on SCD measures in the current project, are referred to as "New-SCD". Interactions were also explored between the groups and timepoints, to explore whether any changes to performance on neuropsychological tasks differed between the groups over time.

Prior to analyses, assumption testing was completed. Shapiro-Wilk tests were used to assess for normality for both groups (original-SCD and new-SCD) across the timepoints. Several of the subtests were normally distributed across all three timepoints for both groups. However, most of the tests did not meet this assumption for at least one timepoint and/or one group. Repeated measures ANOVAs are considered robust against normality violations (Blanca et al., 2023).

Levene's Tests were used to assess for homogeneity of variance and indicated that all variables met this assumption. Mauchly's Tests were used to assess that the assumption of sphericity was met, which showed several subtests violated this assumption. Therefore, for these variables, degrees of freedom were adjusted using the Greenhouse-Geisser statistic. This statistic was opted for due to the smaller sample size and reduced Type 1 error risk (Blanca et al., 2023).

Table 3 shows the 2x3 ANOVA for the main effects of time. Two tests revealed a statistically significant main effect of time, which were DS N Incorrect, $F(2,40) = 3.45$, $p = .04$, $\eta^2p = .15$ and TMTA completion time, $F(1.4, 25.21) = 4.72$, $p = .03$, $\eta^2p = .21$, both indicating large sized effects. Therefore, for these two tests, there was a significant difference on mean scores overtime.

Bonferroni pairwise comparisons (adjusted $p < .05$) were conducted as post-hoc testing. For DS N Incorrect, there were no significant differences between the timepoints, baseline to follow-up (mean difference =.63, $p = .24$), baseline to 2025, (mean difference = .88, $p = .07$), or 2023/6-month

follow-up to 2025 follow-up (mean difference = .25, p = 1.00). Pairwise comparisons for TMTA completion time were also non-significant for all timepoints, baseline to 2023/2024 follow-up (mean difference = 643.17ms, p = 1.00), baseline to follow-up 2025, (mean difference = .88, p = .07) and 2023/2024 follow-up to 2025 follow-up (mean difference = 5597.52ms, p = .09).

Exploration of the pairwise comparisons indicate, while not statistically significant, mean scores for these tests increased from baseline to 2023/6-month follow-up (indicating increased errors for DS and longer completion time for TMTA) but showed improvement when participants retook the tests in 2025.

Table 3

Mixed 2x3 ANOVA Analysis for main effects of time on neuropsychological testing

Measure	*F*	*df*	*p*	η^2_p
Simple Reaction Task (SRT) Average Time	1.40	1.07, 23.43	.25	.06
SRT Incorrect Response	.92	1.12, 23.47	.36	.04
Digit Span (DS) Correct Responses	1.13	2, 40	.61	.06
DS Incorrect Response*	3.45	2, 40	.04*	.15
DS Longest Span	1.36	2, 40	.27	.06
Picture Recognition (PR) Correct Response	.91	2, 40	.41	.04
PR False Alarms	.35	1.24, 24.80	.61	.02
PR Correct Position	2.44	2, 40	1.00	.03
Sustained Attention Response (SAR) Average Reaction Speed	1.86	1.01. 20.12	.17	.09
SAR Too Soon and Anticipatory Errors	1.63	2, 40	.21	.07
SAR Correct	.69	2, 40	.51	.03
Word Recognition (WR) Correct Responses	1.22	1.40, 27.96	.30	.06
WR Correct Position	2.21	2, 40	.12	1.00
WR False Alarms	1.40	2, 40	.25	.07
Trail Making Task A (TMTA) Completion Time*	4.72	1.4, 25.21	.03*	.21
TMTA Errors	.18	1.5, 27.61	.76	.01
Trail Making Task B (TMTB) Completion Time	.67	1.29, 24.58	.46	.03
TMTB Errors	1.38	1.51, 27.23	.26	.07

* Statistically significant

Table 4

Mixed 2x3 ANOVA Analysis for time x group interaction

Measure	*F*	*df*	*p*	η^2_p
Simple Reaction Task (SRT) Average Time	.55	1.07, 23.43	.45	.03
SRT Incorrect Response	.39	1.12, 23.47	.56	.02
Digit Span (DS) Correct Responses	2.40	2, 40	.10	.11
DS Incorrect Response	.31	2, 40	.74	.02
DS Longest Span	2.12	2, 40	.13	.10
Picture Recognition (PR) Correct Response	.24	2, 40	.72	.01
PR False Alarms	.67	1.24, 24.80	.45	.03
PR Correct Position	.63	2, 40	.53	.03
Sustained Attention Response (SAR) Average Reaction Speed	1.59	1.01. 20.12	.25	.07
SAR Too Soon and Anticipatory Errors	.74	2, 40	.49	.04
SAR Correct	.05	2, 40	.95	.02
Word Recognition (WR) Correct Responses	.90	1.40, 27.96	.39	.04

WR Correct Position	.26	2, 40	.77	.01
WR False Alarms	.81	2, 40	.45	.04
Trail Making Task A (TMTA) Completion Time	1.27	1.4, 25.21	.62	.07
TMTA Errors	.62	1.5, 27.61	.50	.03
Trail Making Task B (TMTB) Completion Time	1.03	1.29, 24.58	.34	.05
TMTB Errors	2.17	1.51, 27.23	.38	.11

CHAPTER EIGHT: Extended Reflections Qualitative Empirical Paper

Philosophical Considerations

This research has been conducted under a critical realist lens. Critical realism assumes the existence of reality is separate to human experience, and interpreted through social, contextual and personal constructs. In the present study, dementia and cognitive decline are defined processes, which I believe are real and can be evidenced through neuroimaging, which can show pathology thus evidence this as a real concept. My position as a critical realist is that they share several similarities in how they present across individuals, and can be objectively measured, while recognising that there may be nuances across how individuals experience cognitive decline.

My position as the lead researcher is that participants' accounts of cognitive decline are recognised as real experiences. However, I also recognise that how participants experience SCD will be different based on personal, social and contextual factors.

In terms of epistemology, critical realism supports the notion that knowledge, and in this case experiences of SCD, are developed through interpretation of the participant accounts of their reality. While SCD does not appear on neuroimaging like objective cognitive decline, it is my stance that we are aware of the existence of SCD through individuals lived experience and subjective accounts. Therefore, the data collected within this research represents the participants' interpretation of SCD.

A reflexive thematic analysis approach was selected within this study as it aligned with the overall aims of the study, which was to understand individuals lived experiences of SCD. Furthermore, this approach allowed for the exploration of the descriptions and examples of SCD provided by participants and gain a deeper understanding of how they reported and related to their experiences.

Furthermore, the researcher also recognises their personal experiences of dementia and the influence this may have throughout the data collection and analysis process. Therefore, a qualitative diary was used for reflection and recordings of thoughts, emotions and possible areas of bias.

Researcher's Personal Reflection

Coming into the project, I was critically aware of my professional and personal background relating to dementia. Additionally, I am aware that my role as Trainee Clinical Psychologist with an interest in Neuropsychology and working with older adults, further influences my understanding of cognition, and my interaction and communications with the people who participated in my study. For example, when participants reported that they were aware their cognition had declined, I noticed a pull want to offer validation or reassuring statements, as I would if working clinically.

I am also aware that my role as a Trainee Clinical Psychologist will have influenced how my participants related to me. While I explained my role, some participants referred to me as a "Doctor" or "Researcher". I felt there was a power imbalance which was uncomfortable at times. I tried to negate this by introducing my role clearly and inviting participants to call me by a more informal variant of my name., as well as gently correcting my title when this arose. However, I am aware that participants will have likely perceived me as an authoritative figure. Often, participants would ask for a summary of their neuropsychological testing scores, and whether they had had achieved similar results to previous testing sessions, which I felt indicated participants felt my role was as an "assessor".

The topic guide was developed using PPI, but my own previous experiences of talking to people who report cognitive changes will have shaped how my questions evolved and developed. While talking to my participants, I was reminded of previous clinical work I had undertaken and noticed that pull to be curious and ask more questions. However, I needed to remind myself of the importance of adhering to the topic guide, and that this meeting was not the same as clinical interviews previously undertaken. Furthermore, my understanding of cognitive decline was different to the participant's, by virtue of my clinical experience and their lived experiences. Throughout my interviews, I reminded myself of this.

I was also aware of my personal experiences of dementia with my grandfather, to whom I have dedicated this thesis to. I am mindful of the early stages of cognitive decline he presented with

prior to being diagnosed with vascular dementia, and that these were signs I had very little understanding of that time. While I was mindful that my role within my research was entirely separate, hearing people describe changes to their physical and cognitive health led me to reflect on how he would have described his experiences. There were times when participants shared experiences or personal stories which resonated, for example one participant shared that he worked in a very similar role to my grandfather and described similar issues which were the first signs he mentioned prior to his diagnosis. I was aware of the emotional impact of parts of this conversation and tried to remain attuned to these feelings while following my topic guide and maintaining an objective approach. Writing my feelings and thoughts down following the interview as I was correcting the transcripts helped with identifying areas of potential bias and trying to account for this in my analysis.

Therefore, my personal experiences of dementia enabled me to present an authentic and understanding side of myself, while my clinical experiences supported in remaining centred and orientated to the goals of my research.

CHAPTER NINE: Extended Discussion and Critical Evaluation

Summary of thesis aims

This thesis aimed to develop the understanding of subjective cognitive decline (SCD) and the potential for further decline, specially within older adult populations. This thesis presents a systematic literature review, synthesising research examining anxiety and depression as potential risk factors for developing objective cognitive decline, such as mild cognitive impairment (MCI) or Alzheimer's disease (AD) over time. An empirical study presented as two separate papers, was completed. This investigated how online neuropsychological test performance changed over a two-year period within a cohort of older adults with SCD. It also examined performance on a novel word-pair learning task developed to measure encoding, consolidation and retention. This was to further develop longitudinal understanding of SCD and identify cognitive domains which may show earlier decline. The second aspect of this paper examined how individuals with SCD experience the perceived changes to their cognition, and how they report these. The findings aimed to inform future clinical practice and assessing and potentially providing cognitive rehabilitation support for people with SCD.

This chapter summarises and critically evaluates the findings of these studies and provides considerations for future clinical practice and research.

Main contributions of the research

Chapter Two presents a systematic literature review and meta-analysis. This indicated that older adults reporting SCD and increased symptoms of depression were more likely to progress to MCI or AD. The same association was not found for anxiety within the review. These findings contradict a meta-analysis conducted by Desai et al., (2021) which indicated anxiety was a better predictor of objective cognitive decline than depression in older adults with SCD. However, both reviews highlight that mood factors in older adults in combination with SCD may present and increased risk of further decline. Therefore, early identification, monitoring and possible treatment may benefit older adults presenting to professionals citing increased depression, anxiety and SCD.

Chapter Four presented the quantitative empirical study. Here, a selection of participants repeated online neuropsychological testing, they previously completed in 2023, with a follow-up six (+/1) month later, with repeated testing in 2025. As part of this study, participants also completed the Verbal Associative Learning and Memory Test (VALMT, McGibbons et al., 2022). The findings indicated that participant performance across the online neuropsychological testing remained stable over the two years. It also found improvements on a test of processing speed, Trail Making Test A. Participants also scored lower on a depression mood measure, indicating a reduction in self-reported symptoms of depression. However, scores of the Cognitive Change Index (Rattanabannakit et al., 2016) were significantly higher with all participants scores indicating they perceived themselves as having SCD. Furthermore, performance on the VALMT showed that older participants took longer to learn all 12 word-pairs on the learning phase. All participants' recall scores declined after the 55-minute and 24-hour delays, suggesting that the VALMT may be sensitive in detecting verbal memory specific difficulties in relation to SCD. Furthermore, poor performance on episodic and verbal memory tasks may be associated with increased risk of SCD developing into MCI (Jester et al., 2022). Therefore, a combination of episodic memory complaints and poorer performance on verbal memory tasks may highlight the specific domains in cognition which highlight individuals with SCD with increased risk of developing objective cognitive decline.

Chapter Five presented a thematic analysis in which participants who had SCD were invited to an interview with the aim of exploring their experiences of SCD, and strategies they use to cope. Findings suggested that participants described "memory" complaints which pertained to attentional, word finding and processing speed difficulties. The literature supports this finding, suggesting that subjective word-finding difficulties for everyday objects in cognitively unimpaired older adults are associated with AD biomarkers and may reflect early stages of neurodegeneration (Montembeault et al., 2022). Additionally, individuals with SCD reporting memory complaints may also be referring to other areas of cognition. Participants also shared concerns regarding to the self-perceived physical health declines and how they felt these impacted their cognition. Furthermore, participants discussed their concerns for the future and the need to plan for further decline and perceived inevitable need for

care. To cope, participants shared using strategies to avoid further decline and increased use of memory aids. Therefore, individuals with SCD may represent a group of people who are increasingly aware of perceived physical and cognitive decline. Despite participants scoring below cut-off on anxiety and depression mood measures, they reported feeling worried regarding the future, with increased focus on their perceived cognitive and health decline.

Overall, this thesis project presents further understanding of SCD longitudinally. The findings of which highlight the importance of understanding depression and anxiety in older adults. While the cohort of older adults within this study scored low for both areas on their mood measures, interviews with participants highlighted their anxieties regarding the future. This may reflect a generational interpretation of mental-health based language such as "anxiety" and "depression". Their anxieties and worries about the future may also have impacted how they perceived their cognition and therefore become more aware of perceived decline. However, if future interventions for supporting older adults with SCD are developed, focus on mood in language that aligns to shared cohort beliefs may be helpful.

Finally, consideration around definitions of SCD may warrant further development. While participants did not demonstrate significant decline on testing, all reported a decline in their cognitive skills. Interviews with participants captured the nature of these perceived changes to be around a range of cognitive domains, such as word-finding and attentional abilities. These were reflected in day-to-day settings, such as losing items around the house, but less so in artificial testing.

Strengths of the research

Systematic Review

The systemic review and meta-analysis were novel within the area of longitudinal research focusing on depression and anxiety within older adults with SCD as predictors for further cognitive decline. In-keeping with good practice, the review was registered on the International Prospective Register of Systematic Reviews (PROSPERO). The review also benefitted from the involvement of

two, independent reviewers who conducted screening of titles and abstract, and full-text screening separately. Inclusion and exclusion criteria were followed throughout this process, and both completed a Risk of Bias measure to assess for inter-rater reliability. Studies included in the review also used similar neuropsychological tests, representing heterogeneity across the studies. The review focused on longitudinal studies with older adult cohorts with SCD identified at baseline and use of measures used for anxiety, depression and cognition. To ensure maximum inclusion of potential papers, any standardised mood measures and neuropsychological tests were included.

Quantitative Empirical Paper

This paper involved repeated neuropsychological testing of a cohort of older adults with SCD over a two-year period. This longitudinal observational method offers several benefits, including allowing for in-depth exploration of cognitive performance overtime (Carunana et al., 2015). The measures used for capturing depression and anxiety were specific to the study population. Therefore, scores accurately reflect how mood symptoms are experienced and reported in the older adult population (Panchana et al., 2007; Sheikh & Yesavage, 1986). Furthermore, the NeurOn online neuropsychological tests utilised for this research demonstrated reasonable test-retest reliability for some tasks (Paterson et al., 2025).

Qualitative Empirical Paper

The qualitative paper involved interviews with 10 older adults who identified as having SCD. The topic guide was informed by current literature and understanding of SCD (Jessen et al., 2014). The use of Patient and Public Involvement (PPI) offered several benefits (Arumugam et al., 2023), such as increasing the validity and meaningfulness of the topic guide by involving the voices, direction and feedback of people who felt they have SCD. The aim of this paper was to gain further understanding of SCD through thematic analysis and identified possible shared experiences between individuals who report SCD.

Limitations of the research

Systematic Review

The systematic-review and meta-analysis had a very small sample size. While this may reflect the novel area of the review, the results need to be interpreted with caution owing to the low number of papers. Due to the small number of papers, further tests for publication bias could not be conducted. Furthermore, a separate grey literature search was not conducted. This further impacts the potential publication bias. The systematic review excluded papers prior to 2014, to ensures literature included was post the SCD-Initiative criteria for defining SCD in research (Jessen et al., 2014). However, this may have led to over-exclusion of papers focusing within this field.

Furthermore, the review was aimed at including papers which measured anxiety and depression, however several papers focused on depression as a factor alone. These were still included in the review. Therefore, anxiety was less represented in the meta-analysis (two studies focused on anxiety and depression, one focused on depression alone), which may have influenced results.

Quantitative Empirical Paper

This study was also limited by its small sample size (n = 26), with all participants reporting they were White British. Due to the longitudinal nature of the study, and the need for participants to have undergone neuropsychological testing as part of a previous study, the researcher was limited to this group for recruitment. Therefore, participants who had provided consent to be re-contacted and had undertaken baseline testing only were invited to the study.

Several participants started, but did not complete, neuropsychological testing. While they did not request to withdraw from the study, they were not included in the analysis, and it was not possible to ascertain the reasons for non-completion. Furthermore, seven participants who undertook the VALMT did not complete the delayed recall trials within the required timeframes. This may reflect a potential limitation with online neuropsychological tests; people may forget to complete them, particularly if there is a timed delayed element. Furthermore, participants were not observed during the testing and therefore may have applied strategies to support them with testing that they would not have been able to do in a face-to-face setting.

Qualitative Empirical Paper

The participants who undertook interviews were also all White British, which may have influenced their experiences and interpretation of their cognitive skills and perceived decline. Furthermore, most of the participants had university-level or equivalent education, which again may influence their beliefs and views of their cognitive skills.

Of the 10 participants interviewed, seven were male, and while they endorsed self-reports of SCD, their understanding, perceived decline and how they related to these experiences may have differed to female, postmenopausal participants.

Recommendations for future clinical practice and research

The systematic review indicated that affective symptoms may increase risk of further cognitive decline in older adults with SCD. Additionally, the results support the notion that SCD can represent an earlier manifestation of MCI or AD. However, it is also important to note that SCD is prevalent in middle and later life and many individuals with SCD will not develop MCI and AD (Pike et al., 2022; Roh et al., 2021). Furthermore, co-morbid anxiety and depression may exacerbate perceptions of cognitive decline (Sabatini et al., 2021). Development of psychological interventions for treating depression in older adults may reduce risk. Observational research examining medication-based treatment for treating older adults with clinical depression may be associated with reduced risk for developing dementia (Yang et al., 2022). Future research is needed to continue exploring the role of anxiety and depression as potential risk factors in developing further cognitive decline in older adults with SCD, along with whether offering treatment for anxiety and depression may present as a preventative measure to reduce this risk.

The findings from the quantitative empirical study indicated that people who report SCD, low symptoms of depression and anxiety, demonstrate limited change on remote neuropsychological testing over a two-year period. Furthermore, within this timeframe, none of the participants reported receiving a diagnosis of MCI. This suggests that, if individuals with SCD do present an increased risk of progressing to MCI, this duration of follow-up may not have been long enough to observe potential

progression. Therefore, future, longitudinal research, could focus on SCD converting to MCI progression rate. This research could involve using a range of follow-up timeframes and comparing to large scale demographical data.

The study also presented the possibility of offering remote, online neuropsychological testing to re-test people with SCD over time. This method may provide benefits for clinical practice. People with SCD are more likely to seek medical care (Jessen et al., 2014). Furthermore, the NHS Ten-Year Plan (NHS England, 2015), states the need to increase digital and remote appointments. Therefore, the use of online neuropsychological testing, may assist in assessing people with SCD and reach more people, without requiring them to travel, which can pose as a barrier for older adults (Hanratty et al., 2012). While clinicians will still be required to interpret the testing results, online neuropsychological testing does not require a clinician to administer and score the tests, saving clinical time (Staffaroni et al., 2020). However, it must be noted that limited clinician observation during online neuropsychological testing poses potential limitation of this method. Questions pertaining to date and time may be impacted by visual prompts on the screen, or individuals may write cues for themselves to present their cognitive abilities more favourably for assessment.

The findings of the qualitative empirical paper suggest that people with SCD, worry about the future and focus on their perceived physical and cognitive health decline. While they cited memory complaints, difficulties they described pertained to other cognitive domains. Therefore, if an individual with SCD presents in a clinical setting citing memory concerns, they may in fact be experiencing attentional and word-finding issues, and increasingly aware of when these are happening in their daily lives. Furthermore, findings indicated that people interpret cognition as a skill which can be trained. This may suggest that individuals with SCD may be supported by memory strategies and cognitive rehabilitation type approaches.

Conclusion

The three studies presented in this thesis further support the notion that SCD may present as an earlier presentation of MCI for some individuals. Furthermore, the studies assist in identifying potential factors that may increase this risk, such as depression. Additionally, the studies support the use of online neuropsychological testing for assessing changes to self-reports and testing over time. Future research is needed to consider how to support older adults reporting SCD and mood symptoms in a manner that supports generation understanding of mental health. Additionally, further consideration of SCD definitions and development of tests that capture the nature of concerns individuals with SCD report is warranted.

Furthermore, the findings from this thesis portfolio indicate several clinical implications. Jessen et al., (2014) suggests that people with SCD are more likely to seek medical support regarding perceived memory concerns. Therefore, there may be a portion of older adults experiencing SCD and increased anxiety and/or depression in relation to their perceived cognitive decline. These individuals may benefit from psychologically informed assessment and formulation of their concerns, with focus on possible anxiety and depression, rather than solely focusing on lack of objective cognitive decline on neuropsychological testing. Additionally, there is potential for psychoeducation around memory aging and the influence of mood as a contributing factor on cognition being developed for this group. Furthermore, language around mental health aligned to potential cohort beliefs and compensatory strategies may further support this group with managing their concerns.

This portfolio also presents implications for the use of online neuropsychological testing, with potential to offer this more routinely in the NHS to monitor people who report cognitive concerns over time. However, the use of online testing has several issues, such as clinicians not being present while the individual undertakes the tests. This presents issues around individuals needing to understand the rules of a task via the instructions presented to them on screen. Without additional monitoring during testing, clinicians will not be able to tell if an individual has completed the tests unassisted, or whether prompts on screen, such as date and time, have been used to present more favourably on testing.

Lastly, this thesis portfolio indicates that the current definition of SCD in the literature may not fully reflect the complex and nuanced nature of SCD. The SCD-I (Jessen et al., 2014) defines SCD as perceived cognitive decline with normal neuropsychological testing, with memory-specific complaints and presence of AD biomarkers being indicative of SCD-plus. However, the findings of this portfolio indicate that people with SCD may experience concerns relating to a range of cognitive domains, physical health and the link between these, such as hearing loss and its association with increased dementia risk. Furthermore, participants did demonstrate accelerated forgetting on the VALMT, suggesting that sensitive, verbal memory tasks may indicate a domain people with SCD demonstrate difficulties in. Therefore, the current definition and understanding of SCD may benefit from being updated to reflect possible associations with physical health concerns within SCD and possible subtle poorer verbal memory performance on sensitive tests.

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Appendices

APPENDIX A

Aging and Mental Health Journal Submission Guidelines

Taken from
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- Review Article

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- Should be between 7,000 and 8,000 words, inclusive of:
    - Tables
    - References
    - Figure or table captions
- Should contain a structured abstract of 200 words.

Objectives, Methods, Results, Conclusion

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APPENDIX B

Newcastle-Ottawa for Cohort Studies

Newcastle-Ottawa Quality Assessment Form for Cohort Studies

Note: A study can be given a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability.

Selection

1) Representativeness of the exposed cohort
   a) Truly representative ***(one star)***
   b) Somewhat representative ***(one star)***
   c) Selected group
   d) No description of the derivation of the cohort
2) Selection of the non-exposed cohort
   a) Drawn from the same community as the exposed cohort ***(one star)***
   b) Drawn from a different source
   c) No description of the derivation of the non exposed cohort
3) Ascertainment of exposure
   a) Secure record (e.g., surgical record) ***(one star)***
   b) Structured interview ***(one star)***
   c) Written self report
   d) No description
   e) Other
4) Demonstration that outcome of interest was not present at start of study
   a) Yes ***(one star)***
   b) No

Comparability

1) Comparability of cohorts on the basis of the design or analysis controlled for confounders
   a) The study controls for age, sex and marital status ***(one star)***
   b) Study controls for other factors (list) _____ ***(one star)***
   c) Cohorts are not comparable on the basis of the design or analysis controlled for confounders

Outcome

1) Assessment of outcome
   a) Independent blind assessment ***(one star)***
   b) Record linkage ***(one star)***
   c) Self report
   d) No description
   e) Other
2) Was follow-up long enough for outcomes to occur
   a) Yes ***(one star)***
   b) No

Indicate the median duration of follow-up and a brief rationale for the assessment above:_____

3) Adequacy of follow-up of cohorts
   a) Complete follow up- all subject accounted for ***(one star)***
   b) Subjects lost to follow up unlikely to introduce bias- number lost less than or equal to 20% or description of those lost suggested no different from those followed. ***(one star)***
   c) Follow up rate less than 80% and no description of those lost
   d) No statement

E-17

Thresholds for converting the Newcastle-Ottawa scales to AHRQ standards (good, fair, and poor):

Good quality: 3 or 4 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain

Fair quality: 2 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain

Poor quality: 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 or 1 stars in outcome/exposure domain

APPENDIX C

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Method: A summary of the participants as well as descriptions of the study design, procedures, and specific key measures, to the extent that space allows.
Results: A summary of the key findings.
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14. **Units.** Please use SI units (non-italicized).

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Disclosure Statement

Please include a disclosure statement, using the subheading "Disclosure of interest." If you have no interests to declare, please state this (suggested wording: *The authors report there are no competing interests to declare*). For all NIH/Welcome-funded papers, the grant number(s) must be included in the declaration of interest statement. Read more on declaring conflicts of interest.

Clinical Trials Registry

In order to be published in a Taylor & Francis journal, all clinical trials must have been registered in a public repository, ideally at the beginning of the research process (prior to participant recruitment). Trial registration numbers should be included in the abstract, with full details in the methods section. Clinical trials should be registered prospectively – i.e. before participant recruitment. However, for clinical trials that have not been registered prospectively, Taylor & Francis journals requires retrospective registration to ensure the transparent and complete dissemination of all clinical trial

results which ultimately impact human health. Authors of retrospectively registered trials must be prepared to provide further information to the journal editorial office if requested. The clinical trial registry should be publicly accessible (at no charge), open to all prospective registrants, and managed by a not-for-profit organization. For a list of registries that meet these requirements, please visit the WHO International Clinical Trials Registry Platform (ICTRP). The registration of all clinical trials facilitates the sharing of information among clinicians, researchers, and patients, enhances public confidence in research, and is in accordance with the ICMJE guidelines.

Ethics of Experimentation

Please ensure that all research reported in submitted papers has been conducted in an ethical and responsible manner, and is in full compliance with all relevant codes of experimentation and legislation. All original research papers involving humans, animals, plants, biological material, protected or non-public datasets, collections or sites, must include a written statement in the Methods section, confirming ethical approval has been obtained from the appropriate local ethics committee or Institutional Review Board and that where relevant, informed consent has been obtained. For animal studies, approval must have been obtained from the local or institutional animal use and care committee. All research studies on humans (individuals, samples, or data) must have been performed in accordance with the principles stated in the Declaration of Helsinki. In settings where ethics approval for non-interventional studies (e.g. surveys) is not required, authors must include a statement to explain this. In settings where there are no ethics committees in place to provide ethical approval, authors are advised to contact the Editor to discuss further. Detailed guidance on ethics considerations and mandatory declarations can be found in our Editorial Policies section on Research Ethics.

Consent

All authors are required to follow the ICMJE requirements and Taylor & Francis Editorial Policies on privacy and informed consent from patients and study participants. Authors must include a statement to confirm that any patient, service user, or participant (or that person's parent or legal guardian) in any type of qualitative or quantitative research, has given informed consent to participate in the research. For submissions where patients or participants can be potentially identified (e.g. a clinical case report detailing their medical history, identifiable images or media content, etc), authors must include a statement to confirm that they have obtained written informed consent to publish the details from the affected individual (or their parents/guardians if the participant in not an adult or unable to give informed consent; or next of kin if the participant is deceased). The process of obtaining consent to publish should include sharing the article with the individual (or whoever is consenting on their behalf), so that they are fully aware of the content of the article before it is published. Authors should familiarise themselves with our policy on participant/patient privacy and informed consent. They may also use the Consent to Publish Form, which can be downloaded from the same Author Services page.

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Please confirm that all mandatory laboratory health and safety procedures have been complied within the course of conducting any experimental work reported in your paper. Please ensure your paper contains all appropriate warnings on any hazards that may be involved in carrying out the experiments or procedures you have described, or that may be involved in instructions, materials, or formulae.

Please include all relevant safety precautions; and cite any accepted standard or code of practice. Authors working in animal science may find it useful to consult the International Association of Veterinary Editors' Consensus Author Guidelines on Animal Ethics and Welfare and Guidelines for the Treatment of Animals in Behavioural Research and Teaching. When a product has not yet been approved by an appropriate regulatory body for the use described in your paper, please specify this, or that the product is still investigational.

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At the point of submission, you will be asked if there is a data set associated with the paper. If you reply yes, you will be asked to provide the DOI, pre-registered DOI, hyperlink, or other persistent identifier associated with the data set(s). If you have selected to provide a pre-registered DOI, please be prepared to share the reviewer URL associated with your data deposit, upon request by reviewers.

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APPENDIX D

UEA Ethical Approval

University of East Anglia
Norwich Research Park
Norwich. NR4 7TJ

Email: ethicsmonitor@uea.ac.uk
Web: www.uea.ac.uk

Study title: Exploring Personal Experiences of Subjective Cognitive Decline: A Mixed-Methods Study on the Use of Online Neuropsychological Testing for Assessing Early Cognitive Changes in Subjective Cognitive Decline and Mild Cognitive Impairment

Application ID: ETH2425-2236 (significant amendments)

Dear Rebecca,

Your application was considered on 24th May 2025 by the FMH S-REC (Faculty of Medicine and Health Sciences Research Ethics Subcommittee).

The decision is: **approved**.

You are therefore able to start your project subject to any other necessary approvals being given.

This approval will expire on **1st July 2026**.

Please note that your project is granted ethics approval only for the length of time identified above. Any extension to a project must obtain ethics approval by the FMH S-REC (Faculty of Medicine and Health Sciences Research Ethics Subcommittee) before continuing.

It is a requirement of this ethics approval that you should report any adverse events which occur during your project to the FMH S-REC (Faculty of Medicine and Health Sciences Research Ethics Subcommittee) as soon as possible. An adverse event is one which was not anticipated in the research design, and which could potentially cause risk or harm to the participants or the researcher, or which reveals potential risks in the treatment under evaluation. For research involving animals, it may be the unintended death of an animal after trapping or carrying out a procedure.

Any amendments to your submitted project in terms of design, sample, data collection, focus etc. should be notified to the FMH S-REC (Faculty of Medicine and Health Sciences Research Ethics Subcommittee) in advance to ensure ethical compliance. If the amendments are substantial a new application may be required.

Approval by the FMH S-REC (Faculty of Medicine and Health Sciences Research Ethics Subcommittee) should not be taken as evidence that your study is compliant with the UK General Data Protection Regulation (UK GDPR) and the Data Protection Act 2018. If you need guidance on how to make your study UK GDPR compliant, please contact the UEA Data Protection Officer (dataprotection@uea.ac.uk).

Please can you send your report once your project is completed to the FMH S-REC (fmh.ethics@uea.ac.uk).

I would like to wish you every success with your project.

On behalf of the FMH S-REC (Faculty of Medicine and Health Sciences Research Ethics Subcommittee)

Yours sincerely,

Dr Paul Linsley

APPENDIX E

Participant Information Sheet (Quantitative Study)

Version 5; 23 May 2025

University of East Anglia

Chief Investigator
Rebecca Leventhall
Department of Clinical Psychology and Psychological Therapies,
School of Medicine,
University of East Anglia
Norwich
NR4 7TJ

PARTICIPANT INFORAMTION SHEET

Exploring Personal Experiences of Subjective Cognitive Decline: A Mixed-Methods Study on the Use of Online Neuropsychological Testing for Assessing Early Cognitive Changes in Subjective Cognitive Decline and Mild Cognitive Impairment.

I would like to invite you to take part in our research study. Before you decide, it is important that you understand why the research is being done and what it would involve for you. Please take time to read this information and discuss it with others if you wish. Please ask if there is anything that is not clear, or if you would like more information.

What is the purpose of this study?

Cases of dementia are expected to rise, therefore there has been more emphasis on earlier detection. Alzheimer's Disease (AD) is the most common form of dementia and can present in three stages; subjective cognitive decline (SCD), mild cognitive impairment (MCI) and AD. However, it is very important to note that the majority of people who report both SCD and MCI do not go on to develop AD.

This study has two main components. First, it involves repeating cognitive tests with participants, both with and without Subjective Cognitive Decline (SCD), to compare their results with those from tests conducted in 2023. Second, it includes interviews with individuals who report SCD or Mild Cognitive Impairment (MCI) to gain insights into their experiences. Therefore, the project aims to develop understanding of SCD and MCI from both a neuropsychological and human perspective.

Why have I been invited?

You have been approached because you participated in a previous study, where you completed online cognitive assessments and expressed interest in future research. We are now reaching out to invite you to take part in a follow-up project that involves repeating the cognitive testing, alongside an additional memory task. As part of this study, we would like to use your previous testing scores. By agreeing to participate, you will also be giving consent for us to include this earlier data in our analysis.

Do I have to take part?

No. Taking part in this research is voluntary. Furthermore, if you agree to take part in the study and later change your mind, you can withdraw without providing a reason.

What will happen to me if I decide to take part?

If you decide to take part, you will be given a link, where you can access an online consent form and a few, brief questionnaires relating to your background, mood and updates since your participation in the previous study.

One you have completed the consent form; you will be sent the links to access the two platforms containing the cognitive tests being used for this study via email. The tests all relate to your thinking, memory and concentration. It is advised to complete the tests using a laptop, computer or tablet on your own.

The first det of tests will be using NeurOn, using the same tests you completed previously, therefore you will need the code you used in the previous study. If you are unsure of your code, please do contact the lead researcher (Rebecca Leventhall, r.leventhall@uea.ac.uk) with your name, and your code will be sent to you. These tasks can take up to an hour to complete and you may also take breaks to assist with concentration.

You will also be asked to complete another memory task called the Verbal Associative Learning and Memory Test (VALMT). This is a learning task with two follow-up memory tasks, 55 minutes and 24 hours later. It is advised that you complete this on a different day to the other cognitive tests to assist with concentration. The learning task of the VALMT can take up to an hour and a half to complete, though you may require less time. The repeat tests after 55 minutes and 24 hours later may take up to an hour or less to complete.

When accessing the VALMT website for the first time, **click the "New Participant" button to generate a unique code**. This code will only be provided to you, so it is essential to share it with the lead researcher at r.leventhall@uea.ac.uk. This ensures your results can be matched with data from other tests and questionnaires. The code will also be required for repeating the tests after 55 minutes and 24 hours, when you access the website as a "**Returning Participant".** Therefore, you may wish to save the code by taking a picture or writing it down, as it will not be reissued. The code is also case sensitive. Once you complete the learning task, you may wish to consider setting a timer on your phone for 55 minutes and a reminder to take the tests again after 24 hours.

The memory and concentration tests involved in this study are as follows:

NeurOn Tests (60 – 90 minutes)	VALMT (60 – 90 minutes)	VALMT 24-hour retake (60 minutes or less)
1. Word learning task 2. Picture Encoding 3. Simple Reaction Time 4. Digit Span Backwards 5. Picture Recognition 6. Word Recall 7. Sustained Attention to Response 8. Trails Making Tests A & B 9. Word recall	1. Word Leaning task 2. Word recall task (55-minute delay)	3. Word Recall task

What should I consider?

If you have been diagnosed with dementia, or any other diagnosis that may impact your thinking, such as stroke or brain injury, you will not meet eligibility for this study, please note that a diagnosis of mild cognitive impairment (MCI), would be considered as eligible for this study,

You can also be enlisted to partake in other projects at the same time as this one.

Are there any disadvantages or risk from taking part?

Some of the questions you will be asked relate to your current health. If you feel concerned regarding your memory or health, it is advised that you speak to your GP, who will be able to direct you to appropriate support.

Are there any benefits from taking part?

While taking part in this study may not present as directly advantageous to you directly, your participation is greatly appreciated and will have contributed to further research into understanding cognition.

Will my General Practitioner (GP) be notified if my test results are different from my previous cognitive tests?

Information relating to your participation will not be shared with your GP. The online cognitive tests you are being asked to complete are not diagnostic, and therefore a change in scores does not necessarily indicate a change in health.

However, should you feel concerned about your memory or your mental health, it is advised that you speak with your GP.

Is taking part confidential?

Yes. Your name and any identifying information will not be included in the study data. Furthermore, if the research is submitted for publication in the future, your identifiable information will not be included, ensuring your anonymity.

However, some information, like your name, will be stored securely to facilitate identification and removal, should you opt to withdraw from the study.

The University of East Anglia, the sponsor of this study, serves as the data controller, meaning that, as researchers from the University, we are responsible for securely managing and appropriately using your information. All data will be archived at the University for up to 10 years after the study concludes.

Will I be paid for taking part?

If participants opt-in, they can be added to a prize draw for a £25 Amazon voucher, if they wish.

What would happen if I chose to leave the study?

If you choose to leave the study, you may do so at any time before data analysis begins by contacting the researcher. You do not need to provide a reason for opting to withdraw from the study.

What will happen with the results of the study?

The anonymised results will be written into a thesis project, which will be submitted to UEA. Furthermore, the project may be submitted for publication.

What if there is a problem?

If you have any worries or questions relating to this study, you can contact the lead researcher via email r.leventhall@uea.ac.uk . If you have further issues, please contact Dr Adrian Leddy (A.Leddy@uea.ac.uk) or Professor Michael Hornberger (M.Hornberger@uea.ac.uk). You can also contact the Dr Sian Coker, Programme Director for the Doctorate in Clinical Psychology (S.Coker@uea.ac.uk)

Gifts

Please be advised that members of the research team cannot accept gifts from participants.

Who has reviewed this study?

All research at the University of East Anglia is reviewed by an independent group of people, called a Research Ethics Committee, to protect participants' interests. This study has been reviewed and given a favourable opinion by the University of East Anglia Faculty of Medicine and Health Sciences Research Ethics Committee.

Participating in future research

If you agree to be contacted about future related research, your contact details would be held separately from this study on a password protected computer in the University of East Anglia School of Medicine. Agreeing to be contacted does not mean you would be obliged to take part in future research.

Research contact details:

If you have any queries relating to this study or would like to speak to a member of the research team, please contact Rebecca Leventhall via email., r.leventhall@uea.ac.uk

Thank you for considering taking part in this study.

APPENDIX F

Participant Information Sheet (Qualitative study)

Version 1; 02 November 2024

University of East Anglia

Chief Investigator
Rebecca Leventhall
Department of Clinical Psychology and Psychological Therapies,
School of Medicine,
University of East Anglia
Norwich
NR4 7TJ

PARTICIPANT INFORAMTION SHEET

Exploring Personal Experiences of Subjective Cognitive Decline: A Mixed-Methods Study on the Use of Online Neuropsychological Testing for Assessing Early Cognitive Changes in Subjective Cognitive Decline and Mild Cognitive Impairment.

I would like to invite you to take part in our research study. Before you decide, it is important that you understand why the research is being done and what it would involve for you. Please take time to read this information and discuss it with others if you wish. Please ask if there is anything that is not clear, or if you would like more information.

What is the purpose of this study?

Cases of dementia are expected to rise, therefore there has been more emphasis on earlier detection. Alzheimer's Disease (AD) is the most common form of dementia and can present in three stages; subjective cognitive decline (SCD), mild cognitive impairment (MCI) and AD. However, it is very important to note that the majority of people who report both SCD and MCI do not go on to develop AD.

This study has two main components. First, it involves repeating cognitive tests with participants, both with and without Subjective Cognitive Decline (SCD), to compare their results with those from tests conducted in 2023. Second, it includes interviews with individuals who report SCD or Mild Cognitive Impairment (MCI) to gain insights into their experiences. Therefore, the project aims to develop understanding of SCD and MCI from both a neuropsychological and human perspective.

Why have I been invited?

You have been approached because you participated in a previous study, where you completed online cognitive assessments and expressed interest in future research. As part of the previous project, you indicated that you felt you experience SCD and/or have been informed you have MCI.

We are now reaching out to invite you to take part in a follow-up project that involves taking part in an interview focusing on your memory and other cognitive changes you may have noticed. The interview, which will be arranged with you, will take place via to take place via Microsoft Teams or telephone and is estimated to be around 45 - 50 minutes. Please be

advised that the calls will be recorded for transcription purposes only, and that only audio information will be recorded (i.e. your image/videos of you will not be captured).

Do I have to take part?

No. Taking part in this research is voluntary. Furthermore, if you agree to take part in the study and later change your mind, you can withdraw without providing a reason.

What will happen to me if I decide to take part?

If you decide to take part, you will receive contact from your identified preferred method of contact (e.g. text, email) from the researcher to arrange a date and time to speak. Once this has been arranged, the researcher will send you an "invitation" Via Microsoft Teams, which will contain the link to complete the interview.

The interview is expected to last around 45-50 minutes, though may be completed in less time. Interview questions will focus on cognitive changes that you have noticed, how these present for you on a day-to-day basis, and how you cope with them. We will also have space at the end of the interview to check-in with your wellbeing.

What should I consider?

If you have been diagnosed with dementia, or any other diagnosis that may impact your thinking, such as stroke or brain injury, you will not meet eligibility for this study, please note that a diagnosis of mild cognitive impairment (MCI), would be considered as eligible for this study,

You can also be enlisted to partake in other projects at the same time as this one.

Are there any disadvantages or risk from taking part?

Some of the questions you will be asked relate to your current health. If you feel concerned regarding your memory or health, it is advised that you speak to your GP, who will be able to direct you to appropriate support.

Are there any benefits from taking part?

While taking part in this study may not present as directly advantageous to you directly, your participation is greatly appreciated and will have contributed to further research into understanding cognition.

Will my General Practitioner (GP) be notified if I report I am worried about my cognitive and/or mental health?

Information relating to your participation will not be shared with your GP. However, should you feel concerned about your cognition or your mental health, it is advised that you speak with your GP. The researcher can also share details of organisations (e.g. Age UK) that you can contact for additional information and support, if you wish.

Version 1; 02 November 2024

Is taking part confidential?

Yes. Your name and any identifying information will not be included in the study data. Furthermore, if the research is submitted for publication in the future, your identifiable information will not be included, ensuring your anonymity.

However, some information, like your name, will be stored securely to facilitate identification and removal, should you opt to withdraw from the study.

The University of East Anglia, the sponsor of this study, serves as the data controller, meaning that, as researchers from the University, we are responsible for securely managing and appropriately using your information. All data will be archived at the University for up to 10 years after the study concludes.

Will I be paid for taking part?

If participants opt-in, they can be added to a prize draw for a £25 Amazon voucher, if they wish.

What would happen if I chose to leave the study?

If you choose to leave the study, you may do so at any time before data analysis begins by contacting the researcher. You do not need to provide a reason for opting to withdraw from the study.

What will happen with the results of the study?

The anonymised results will be written into a thesis project, which will be submitted to UEA. Furthermore, the project may be submitted for publication.

What if there is a problem?

If you have any worries or questions relating to this study, you can contact the lead researcher via email r.leventhall@uea.ac.uk . If you have further issues, please contact Dr Adrian Leddy (A.Leddy@uea.ac.uk) or Professor Michael Hornberger (M.Hornberger@uea.ac.uk). You can also contact the Dr Sian Coker, Programme Director for the Doctorate in Clinical Psychology (S.Coker@uea.ac.uk)

Who has reviewed this study?

All research at the University of East Anglia is reviewed by an independent group of people, called a Research Ethics Committee, to protect participants' interests. This study has been reviewed and given a favourable opinion by the University of East Anglia Faculty of Medicine and Health Sciences Research Ethics Committee.

Participating in future research

Version 1; 02 November 2024

If you agree to be contacted about future related research, your contact details would be held separately from this study on a password protected computer in the University of East Anglia School of Medicine. Agreeing to be contacted does not mean you would be obliged to take part in future research.

Research contact details:

If you have any queries relating to this study or would like to speak to a member of the research team, please contact Rebecca Leventhall via email., r.leventhall@uea.ac.uk

Thank you for considering taking part in this study.

APPENDIX G

Participant Consent Form (Qualitative study)

Version 2; 03 November 2024

Chief Investigator
Rebecca Leventhall
Department of Clinical Psychology and Psychological Therapies,
School of Medicine,
University of East Anglia
Norwich
NR4 7TJ

CONSENT FORM

Study title: Exploring Personal Experiences of Subjective Cognitive Decline: A Mixed-Methods Study on the Use of Online Neuropsychological Testing for Assessing Early Cognitive Changes in Subjective Cognitive Decline and Mild Cognitive Impairment

Name of Researcher: Rebecca Leventhall

Name of Participant: Date:

If you agree, please initial box

1. I confirm that I have read the information sheet dated..... for this study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2. I understand that my participation is voluntary and that I am free to withdraw at any point until the data is recorded on the database at which point it will become anonymous and will no longer be possible to remove	
3. I consent for my data collected from my participation in the project titled: "Characterisation of online, remote neuropsychological test performance in people with and without subjective cognitive decline" to be accessed as part of the data for this project.	
4. I understand that the data collected as part of this study will be anonymised so that I am not identifiable when this study is disseminated (e.g. submitted for making, future publications, academic conferences)	
5. I understand that the data obtained will be stored on secure networks within the University of East Anglia and that only authorised members of the study team will have access to personally identifiable information.	
6. I agree to take part in this study.	
Optional:	
7. I agree to be contacted about ethically approved research studies for which I may be suitable. I understand that agreeing to be contacted does not oblige me to participate in any further studies.	
8. I agree for my anonymised data to be used in future research which has ethical approval.	

APPENDIX H

Consent Form (Qualitative study)

Version 2; 03 November 2024

University of East Anglia

Chief Investigator
Rebecca Leventhall
Department of Clinical Psychology and Psychological Therapies,
School of Medicine,
University of East Anglia
Norwich
NR4 7TJ

CONSENT FORM

Study title: Exploring Personal Experiences of Subjective Cognitive Decline: A Mixed-Methods Study on the Use of Online Neuropsychological Testing for Assessing Early Cognitive Changes in Subjective Cognitive Decline and Mild Cognitive Impairment

Name of Researcher: Rebecca Leventhall

Name of Participant:

Date:

If you agree, please initial box

1. I confirm that I have read the information sheet dated…… for this study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2. I understand that my participation in the interview is voluntary and that I am free to withdraw at any point until the data is recorded on the database at which point it will become anonymous and will no longer be possible to remove	
3. I agree for the interview to be audio recorded for the use of transcription purposes only and understand that the audio recordings will be destroyed once transcription has taken place.	
4. I understand that my information will be anonymised so that I cannot be identified. If the research is submitted for publication, I understand that I may see quotations from the interview and consent for this to be used.	
5. I understand that data collected during the interview may be looked at by individuals within the research team, where it is relevant to my taking part in this research. I give permission for these individuals to access my data.	
6. I understand that the data obtained will be stored on secure networks within the University of East Anglia and that only authorised members of the study team will have access to personally identifiable information.	
7. I agree to take part in this interview.	
Optional:	

8. I agree to be contacted about ethically approved research studies for which I may be suitable. I understand that agreeing to be contacted does not oblige me to participate in any further studies.	
9. I agree for my anonymised data to be used in future research which has ethical approval.	

APPENDIX I

Permissions to use the Cognitive Change Index



SJ

Saykin, Andrew J <asaykin@iupui.edu>

To: Rebecca Leventhall (MED - Postgraduate Researcher)

Reply Reply all Forwar

Flagged

Cognitive Change Index (CCI)... 154 KB

Cognitive_Change_Index_20_... 133 KB

Cognitive_Change_Index_20_... 128 KB

3 attachments (415 KB) Save all to OneDrive - University of East Anglia Download all

Warning: This email is from outside the UEA system. Do not click on links or attachments unless you expect them from the sender and know the content is safe.

Dear Rebecca,

Attached please find the latest forms of the CCI and some background information that you may find helpful.

Feel free to reach out if you have questions.

Best wishes,
Andy Saykin

Andrew J. Saykin, PsyD, ABCN
Raymond C. Bealer Professor of Radiology and Imaging Sciences
Professor of Medical and Molecular Genetics
Director, Indiana Alzheimer's Disease Research Center
Director, Center for Neuroimaging
IU Health Neuroscience Center, Suite 4100
Indiana University School of Medicine
355 West 16th Street, Indianapolis, IN 46202
Email: asaykin@iu.edu; Tel: (317) 963-7501; Fax: (317) 963-7547

Subject ID: _____ Date: _____

Cognitive Change Index (CCI-20-I) (INFORMANT VERSION)

These ratings are being completed about: _____

My relationship to participant:
Spouse/partner Daughter/Son Friend Caregiver Other: _____

Average number of hours per week spent with participant: _____(hours/week)

Number of years I have known the participant: _____ (years)

Completed _____ in-person _____ phone

A. Do you feel like his/her memory is becoming worse? (Check only one)

☐ **No** ☐ **Yes, but this does not worry me** ☐ **Yes and this worries me**

B. Instructions:

This scale asks you to rate the participant's abilities, problem areas, daily functioning and activities. Please rate his or her **current** level of ability **compared to 5 years ago** and the severity of any current problems. Remember, you are describing how he or she is functioning now (meaning during the past month including today) compared to 5 years ago. Please rate any changes in his or her ability on the following 5-point scale, choosing the best fitting rating for each item describing a cognitive function or ability:

1. **Normal Ability (No Change or Better than 5 years ago)**: not a problem; no effect on daily activities; no assistance needed

2. **Slight/Occasional Problem (Minimal Change from 5 years ago)**: subtle; occurs less than once a week; may be slightly slower or less efficient; no assistance needed with ability; probably not noticeable to most other people

3. **Mild Problem (Some Change from 5 years ago)**: A bit worse, may perform related activity more slowly or less efficiently; occasionally may need a little help; may be noticeable to others

4. **Moderate Problem (Clearly Noticeable Change from 5 years ago)**: frequent problem; may affect complex activities on a daily basis or several times per week; often needs some assistance to perform complex activity

5. **Severe Problem (Much Worse than 5 years ago)**: continuous problem; unable to independently perform complex activity; requires ongoing assistance or supervision

My confidence in the accuracy of these ratings:
Very High _____
Good _____
Low _____
Very Low _____

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Subject ID: _____ Date: _____

Circle the number that best fits his or her current ability level compared to 5 years ago, using the scale from 1 to 5 below. Select the best choice for each item and *please do not skip any questions*:

Normal Ability	Slight/Occasional Problem	Mild Problem	Moderate Problem	Severe Problem
No Change *(compared to 5 years ago)*	Minimal Change *(compared to 5 years ago)*	Some Change *(compared to 5 years ago)*	Clearly Noticeable Change *(compared to 5 years ago)*	Much Worse *(compared to 5 years ago)*
1	2	3	4	5

1. Recalling information when he or she really tries:	**1**	**2**	**3**	**4**	**5**
2. Remembering names & faces of new people he/she meets:	**1**	**2**	**3**	**4**	**5**
3. Remembering things that have happened recently:	**1**	**2**	**3**	**4**	**5**
4. Recalling conversations a few days later:	**1**	**2**	**3**	**4**	**5**
5. Remembering where things are usually kept:	**1**	**2**	**3**	**4**	**5**
6. Remembering new information told to him or her:	**1**	**2**	**3**	**4**	**5**
7. Remembering where he or she placed familiar objects:	**1**	**2**	**3**	**4**	**5**
8. Remembering what he or she intended to do:	**1**	**2**	**3**	**4**	**5**
9. Remembering names of family members and friends:	**1**	**2**	**3**	**4**	**5**
10. Remembering without notes and reminders:	**1**	**2**	**3**	**4**	**5**
11. As an observer, I consider his or her memory to be:	**1**	**2**	**3**	**4**	**5**
12. Remembering things compared to his or her age group:	**1**	**2**	**3**	**4**	**5**
13. Making decisions about everyday matters:	**1**	**2**	**3**	**4**	**5**
14. Reasoning through a complicated problem:	**1**	**2**	**3**	**4**	**5**
15. Focusing on goals and carrying out a plan:	**1**	**2**	**3**	**4**	**5**
16. Shifting easily from one activity to the next:	**1**	**2**	**3**	**4**	**5**
17. Organizing his or her daily activities:	**1**	**2**	**3**	**4**	**5**
18. Understanding conversations:	**1**	**2**	**3**	**4**	**5**
19. Expressing himself or herself when speaking:	**1**	**2**	**3**	**4**	**5**
20. Following a story in a book, movie or TV:	**1**	**2**	**3**	**4**	**5**

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APPENDIX J

Geriatric Depression Scale

Geriatric Depression Scale (short form)

Instructions: Circle the answer that best describes how you felt over the past week.

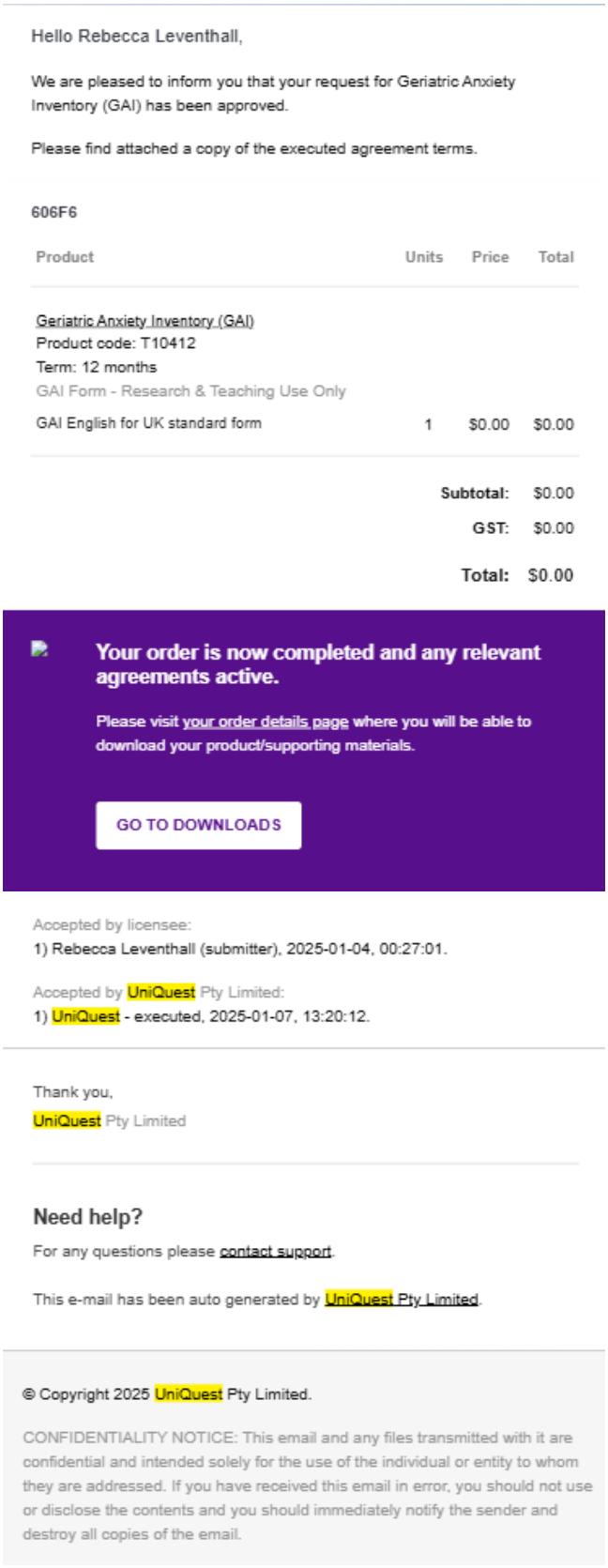
1.	Are you basically satisfied with your life?	yes	no
2.	Have you dropped many of your activities and interests?	yes	no
3.	Do you feel that your life is empty?	yes	no
4.	Do you often get bored?	yes	no
5.	Are you in good spirits most of the time?	yes	no
6.	Are you afraid that something bad is going to happen to you?	yes	no
7.	Do you feel happy most of the time?	yes	no
8.	Do you often feel helpless?	yes	no
9.	Do you prefer to stay at home, rather than going out and doing things?	yes	no
10.	Do you feel that you have more problems with memory than most?	yes	no
11.	Do you think it is wonderful to be alive now?	yes	no
12.	Do you feel worthless the way you are now?	yes	no
13.	Do you feel full of energy?	yes	no
14.	Do you feel that your situation is hopeless?	yes	no
15.	Do you think that most people are better off than you are?	yes	no

Total Score _____

1 Tools may be copied without permission

APPENDIX K

Permissions to use the Geriatric Anxiety Inventory



Hello Rebecca Leventhall,

We are pleased to inform you that your request for Geriatric Anxiety Inventory (GAI) has been approved.

Please find attached a copy of the executed agreement terms.

606F6

Product	Units	Price	Total
Geriatric Anxiety Inventory (GAI) Product code: T10412 Term: 12 months GAI Form - Research & Teaching Use Only			
GAI English for UK standard form	1	$0.00	$0.00

Subtotal: $0.00

GST: $0.00

Total: $0.00

Your order is now completed and any relevant agreements active.

Please visit your order details page where you will be able to download your product/supporting materials.

GO TO DOWNLOADS

Accepted by licensee:
1) Rebecca Leventhall (submitter), 2025-01-04, 00:27:01.

Accepted by UniQuest Pty Limited:
1) UniQuest - executed, 2025-01-07, 13:20:12.

Thank you,
UniQuest Pty Limited

Need help?

For any questions please contact support.

This e-mail has been auto generated by UniQuest Pty Limited.

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Geriatric Anxiety Inventory



Please answer the items according to how you've felt in the last week.

Tick the column under Agree if you mostly agree that the item describes you;
tick the column under Disagree if you mostly disagree that the item describes you.

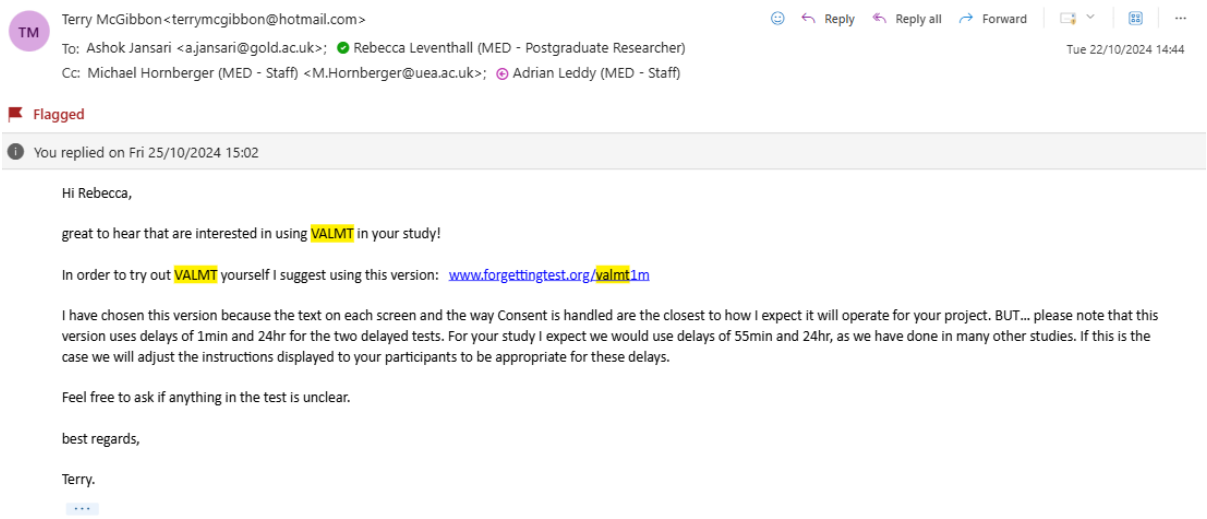
	Agree	Disagree
I worry a lot of the time.		
I find it difficult to make a decision.		
I often feel jumpy.		
I find it hard to relax.		
I often cannot enjoy things because of my worries.		
Little things bother me a lot.		
I often feel like I have butterflies in my stomach.		
I think of myself as a worrier.		
I can't help worrying about even trivial things.		
I often feel nervous.		
My own thoughts often make me anxious.		
I get an upset stomach due to my worrying.		
I think of myself as a nervous person.		
I always anticipate the worst will happen.		
I often feel shaky inside.		
I think that my worries interfere with my life.		
My worries often overwhelm me.		
I sometimes feel a great knot in my stomach.		
I miss out on things because I worry too much.		
I often feel upset.		

Original GAI reference: Pachana, N.A., Byrne, G.J., Siddle, H., Koloski, N., Harley, E., & Arnold, E. (2007). Development and validation of the Geriatric Anxiety Inventory. International Psychogeriatrics, 19, 103-114.

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APPENDIX L

Permission to use the Verbal Associative Learning and Memory Test



Terry McGibbon<terrymcgibbon@hotmail.com>

Reply Reply all Forward

To: Ashok Jansari <a.jansari@gold.ac.uk>; Rebecca Leventhall (MED - Postgraduate Researcher)

Tue 22/10/2024 14:44

Cc: Michael Hornberger (MED - Staff) <M.Hornberger@uea.ac.uk>; Adrian Leddy (MED - Staff)

Flagged

You replied on Fri 25/10/2024 15:02

Hi Rebecca,

great to hear that are interested in using VALMT in your study!

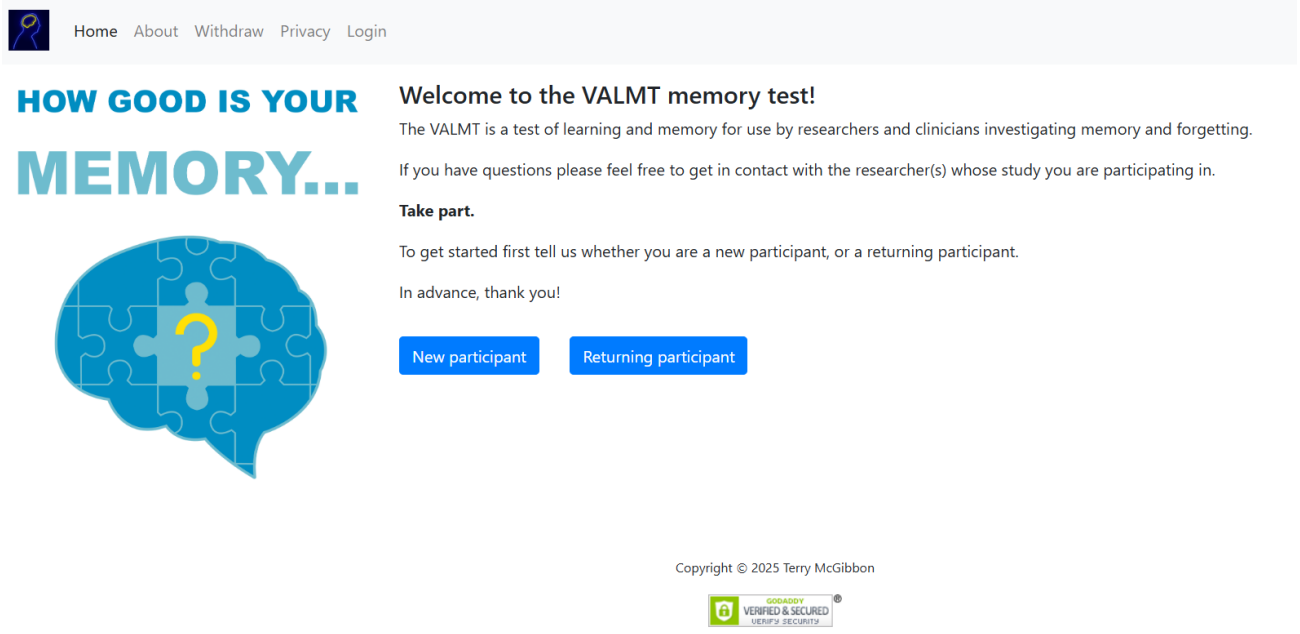
In order to try out VALMT yourself I suggest using this version: www.forgettingtest.org/valmt1m

I have chosen this version because the text on each screen and the way Consent is handled are the closest to how I expect it will operate for your project. BUT... please note that this version uses delays of 1min and 24hr for the two delayed tests. For your study I expect we would use delays of 55min and 24hr, as we have done in many other studies. If this is the case we will adjust the instructions displayed to your participants to be appropriate for these delays.

Feel free to ask if anything in the test is unclear.

best regards,

Terry.



APPENDIX M

Topic Guide

Draft Topic Guide

This topic guide has been developed using Public and Patient Involvement (PPI)

Goals of the interviews

- To establish which cognitive symptoms people with SCD (or SCD which has since been diagnosed as MCI) first noticed
- To explore hoe people made sense of these symptoms, their experiences and how they manage daily

Introductions (10 mins)

- Researcher introduces self
- Instructions for the interview: "You have been invited to participate in this interview as part of my thesis project, which explores people's experiences with their cognition (memory and thinking skills). Since you previously took part in a related project on cognition, you've been invited today to discuss your personal experiences in more detail. Our conversation will last approximately 50 minutes, and there will be time at the end for any questions you may have about our conversation."
- Check consent to continue
- Time for any questions/clarifications from participants

Discussion around cognition (30 – 40 mins)

- What changes have you noticed to your cognition (**SAY:** memory and thinking skills)?
- What were the first changes you noticed?
- How would you describe/have you aware of any changes to your:

- Concentration?
- Forgetting and finding words?
- Thinking speed?
- Co-ordination?

Explore which of these was most noticeable first, when it started, any changes

- Is there anything you do to help?
- How do you manage?
- Do you notice variation to your cognition e.g. "good" and "bad" days?
- What do you think contributes, if so?
- Is there anything else you would like to add?

Conclusion (10 mins)

- Summarise conversation
- Thank participant for their time
- Check-in, "How are you feeling after our conversation?"
- Questions/thoughts from participant
- Explain right to withdraw and where to find research contact details (Participant Information Sheet)