Exploring the effectiveness of Errorless Learning and use of memory aids for people with dementia and Mild Cognitive Impairment.

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Foreword

This foreword highlights the impact of COVID-19 on the Major Research Project process. The researcher had originally completed a proposal for a project exploring the use of the ApplTree smartphone App as a memory aid for people with dementia. However, due to the restrictions on face-to-face contact with participants during the Covid-19 pandemic, the researcher was unable to continue with this project. The development of the current project therefore had an impact on the timescale which the researcher had to complete ethics procedures and subsequent recruitment and data collection for this project.

Chapter 1: Systematic Review

The effectiveness of errorless learning for adults with dementia or mild cognitive impairment: a systematic review

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Prepared in accordance with the author requirements for *Neuropsychological Rehabilitation* (see Appendix 1.1)

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Abstract

Background: Preliminary evidence suggests that errorless learning may be an effective learning approach for people with memory impairments. This systematic review provides a narrative synthesis of the literature examining the effectiveness of errorless learning for people with dementia or Mild Cognitive Impairment.

Method: A systematic search was conducted using MEDLINE, EMBASE, PsychINFO and CINAHL databases. Inclusion criteria were implemented and risk of bias assessed.

Results: From 431 records which were screened, 66 full texts were reviewed for eligibility. Of these, 23 papers met criteria and were included in the synthesis. Overall, there are ambiguous results as to whether errorless learning is more effective than trial and error learning for people with dementia or Mild Cognitive Impairment. However, the findings indicate that errorless learning is effective for word learning.

Discussion: There is evidence that reducing the likelihood of making errors during learning improves learning efficiency for people with dementia or MCI. However, evidence for the benefit of errorless learning is strongest for artificial tasks such as word list learning, whilst results for studies investigating learning of real-life tasks is more equivocal. Further research regarding which form of errorless learning method is most effective, for what tasks and over what time periods is required.

Keywords: Dementia, Mild Cognitive Impairment, errorless learning

1. Introduction

Rationale

Early detection and diagnosis of dementia provides an opportunity to intervene to support learning of important knowledge or skills (Clare et al., 2000). This is crucial in ensuring people with dementia (PWD) can live as independently as possible whilst improving quality of life of the individual and carers (de Werd et al., 2013). Sohlberg and Mateer (2001) refer to cognitive rehabilitation as "the therapeutic process of increasing or improving an individual's capacity to process and use incoming information so as to allow increased functioning in everyday life" (p. 3). Cognitive rehabilitation helps people to compensate for cognitive deficits, which can reduce the daily impact of these impairments (Wilson, 2000).

There is conflicting evidence regarding the effectiveness of cognitive rehabilitation for PWD. A previous systematic review found that overall evidence supports the use of cognitive interventions for PWD, although methodological flaws were frequent (Hooper et al., 2013). Additionally, a recent trial investigating whether individual goal-oriented cognitive rehabilitation improves everyday functioning for PWD found that 10 weekly sessions of cognitive rehabilitation with four additional maintenance sessions significantly increased goal attainment of activities of daily living (ADL's) (Clare et al., 2019). By contrast, a recent Cochrane review found that although cognitive training had a small-moderate effect on global cognition when compared to a control, there was little to no effect when compared to an alternative treatment (Bahar-Fuchs et al., 2019). Similarly, Bahar-Fuchs er al. (2013) found no significant effect of cognitive rehabilitation/training on any of their outcomes, including cognitive functioning, mood or ADL's, for people with mild-moderate Alzheimer's disease (AD) and Vascular Dementia. It was noted in both reviews that the overall quality of the studies was low and the need for high quality studies was highlighted.

Various compensatory approaches are used within cognitive rehabilitation, one of which is errorless learning (EL). The aim of EL is to avoid, or minimise, the chance of making errors during the learning process (Clare & Jones, 2008). This may be achieved by splitting a task into smaller steps, the correction of errors immediately, promotion of not guessing the answer and modelling the correct steps (de Werd et al., 2013). Standard EL tends to be more passive meaning there is little retrieval effort required. However, two specific techniques that provide multiple retrieval opportunities and reduce errors during the learning process, and are therefore considered EL techniques within this review, are Spaced Retrieval (SR), in which individuals are asked to recall information over gradually increasing time intervals (Brush and Camp, 2008), and Vanishing Cues (VC) which involves gradually decreasing cues as the individual learns the correct response (Haslam et al., 2010).

The precise mechanism by which EL may improve learning is not clear, but the interaction of explicit and implicit memory processes is argued to be important (Baddeley & Wilson, 1994). Explicit memory involves conscious retrieval of facts and previous experiences and includes both episodic and semantic memory; whereas implicit memory involves unconscious retrieval and includes procedural memory of learned skills and tasks. Explicit learning is enabled by allocating full attention to the information being encoded, "and elaborating it as richly and deeply as possible" (Baddeley & Wilson, 1994, p. 53). In comparison, implicit learning does not involve the same level of encoding and thus there may not be any memory of the initial encoding of the information during retrieval (Baddeley & Wilson, 1994). Explicit memory is affected in people with amnesia, but implicit memory is typically unaffected (Kuzis et al., 1999). If errors are made during learning, implicit memory will store the error, but the fact that it is an error is not retained as this requires explicit memory. As a result, the error is primed and so likely to be repeated (Kessels and de Haan, 2003). EL therefore aims to minimise the number of errors made during learning to increase the chance of the correct information being encoded.

Although a previous systematic review found positive outcomes for the use of EL for PWD to learn facts and procedures relevant to Speech and Language Therapy tasks (Hooper et al., 2013), this review will update this evidence whilst also encompassing a broader range of outcomes. This review will therefore critically appraise and synthesise the evidence investigating the effectiveness of EL for PWD or Mild Cognitive Impairment (MCI). This review only included MCI with memory impairment other variants of MCI were not included in the reviewed papers.

Objectives

1) Collate the research investigating the effectiveness of EL for PWD or Mild Cognitive Impairment (MCI).

2) Critically assess the quality of the evidence available in the current literature and present a synthesis of the findings.

2. Methods

This review was completed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021).

2.1 Eligibility criteria

Articles were eligible if they met the following criteria:

1) Participants were adults with a progressive dementia or MCI.
2) Quantitative approach.
3) Compared EL in PWD or MCI to at least one other learning condition/learning as usual. Studies which only compared different conditions of EL were excluded (including EL compared to SR and/or VC).
4) Studies including EL as part of a multifaceted cognitive rehabilitation intervention were excluded.
5) Studies employing between-subjects designs and within-subjects studies where learning conditions are compared were included. However, studies using a simple pre-post design were excluded. Studies using a single-case experimental design were included but other case studies/series were excluded.
6) Written in English.
7) Published in a peer-reviewed journal.

2.2 Information sources

The following databases were systematically searched: Excerpta Medica Database (EMBASE) and Medical Literature Analysis and Retrieval System Online (MEDLINE) via OVID; Cumulative Index to Nursing and Allied Health Literature (CINAHL) and PsycINFO via EBSCO. Databases were searched from their inception for relevant published literature. The reference lists of included papers were also searched.

The searches were completed on 23rd March 2021 using the University of Glasgow library service (http://eleanor.lib.gla.ac.uk).

2.3 Search strategy

Table 1: Search strategy (Ovid MEDLINE)

Source	**Search strategy**
Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions(R) <1946 to March 23, 2021>	1. exp Neurocognitive Disorders 2.exp Dementia 3. exp Alzheimer Disease 4. exp Dementia, Vascular 5. exp Lewy Body Disease 6. exp Frontotemporal Dementia 7. exp Cognitive Dysfunction 8.mild cognitive impairment.mp 9.dement*.mp 10. alzheimer*.mp 11.(lewy* adj2 bod*) 12. (pick* adj2 disease). 13. "Parkinson* disease dementia".mp 14. organic brain disease.mp 15. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 16. vanishing cue*.mp 17. spaced retrieval 18. errorless learning.mp 19. error-less learning.mp 20. errorless skill learning.mp 21. 16 or 17 or 18 or 19 or 20 22. 15 and 21

A full description of the search strategies for each database can be found in appendix 1.2.

2.4 Selection Process

The searches produced an initial set of 781 articles. To remove duplicates, Endnote’s auto de-duplicate tool was used which was followed by manual de-duplication. The titles and abstracts of the remaining 431 articles were then reviewed against inclusion/exclusion criteria. For articles potentially eligible, full texts were obtained and reviewed. Those that met the criteria were included in the review. The author independently completed this process. However, if there was uncertainty as to whether a paper met the inclusion criteria, these were discussed with a supervisor.

2.5 Data collection process

The author independently reviewed the included articles and extracted the relevant information in accordance with the data items below.

2.6 Data items

The following data were extracted from the included studies: General study information (author(s), date of publication, country), study aims and design, number of participants (split by experimental/control condition if relevant), participant characteristics (age, gender, MMSE score, diagnosis), primary outcome measure (task being learned), details of the EL intervention, summary of results, quality rating and limitations.

2.7 Study risk of bias assessment

The Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (Kmet et al., 2004) was used to evaluate methodological quality. This tool is a 14-item rating scale relating to how the study was conducted/reported, with each item having four possible responses of "yes" (2 points), "partial" (1 point), "no" (0 points) or "n/a" (0 points). The ratings range from 'low', 'moderate' or 'high' and a full description of the scoring can be found in appendix 1.4.

The author performed quality assessment of all articles included and a second independent reviewer reviewed 13 out of the 23 included articles (56%) to verify inter-rater reliability of the ratings (95% inter-rater reliability. Discrepancies in scoring between the raters were resolved through discussion and are presented in appendix 1.3.

2.8 Synthesis methods

Due to methodological variability within the included studies, a meta-analysis was not appropriate. A narrative synthesis approach was therefore used to address this heterogeneity and to produce a synthesis of the results and limitations of the studies (Popay et al., 2006).

3. Results

3.1 Study selection

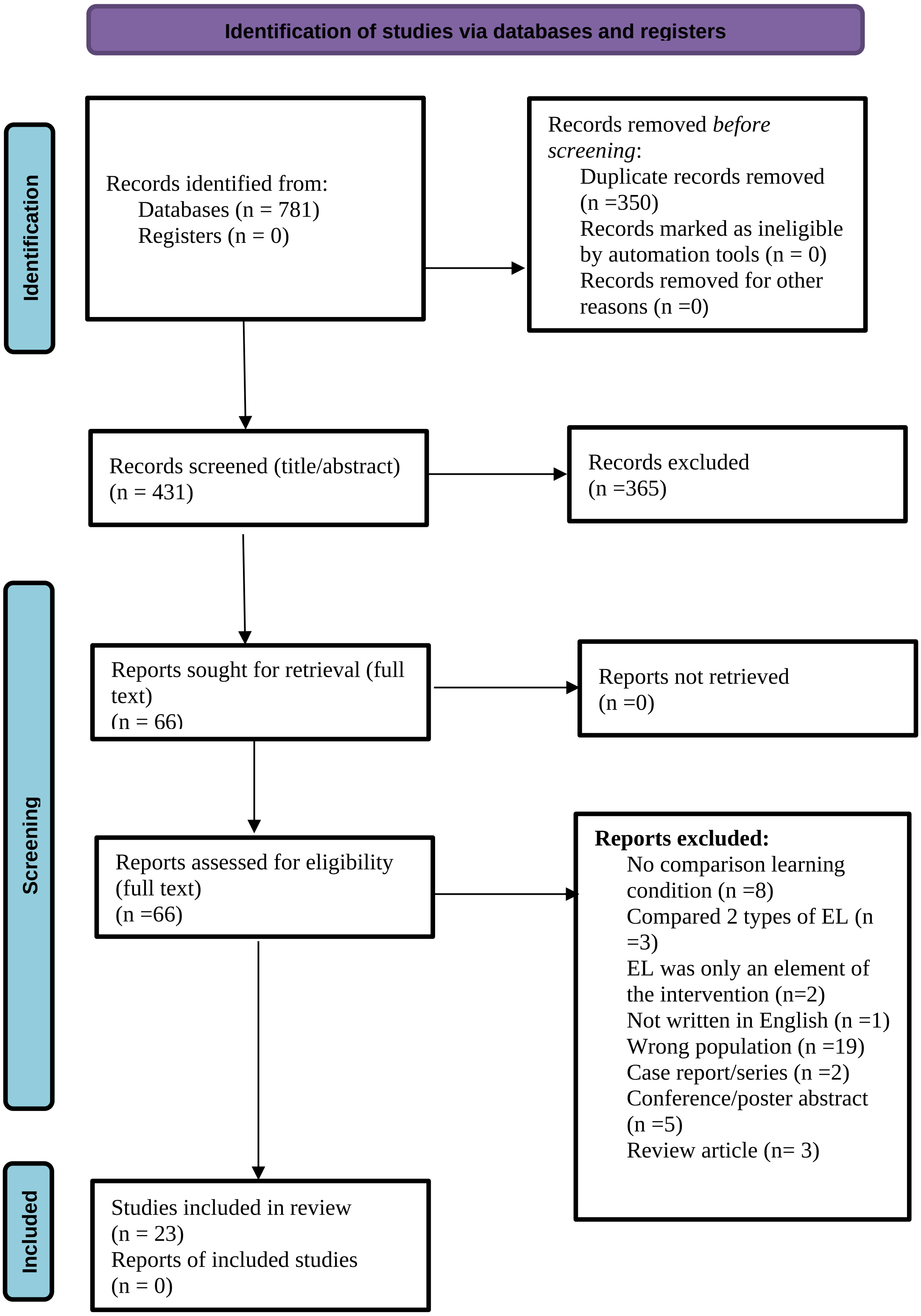

Figure 1: Flow chart of systematic search process and study selection (based on PRSIMA, 2020).

3.2 Study characteristics

Twenty-three articles were included with 808 participants. Nine of these studies included participants with Alzheimer's Dementia (AD), seven studies included participants with dementia (usually comprising of AD, vascular dementia or mixed dementia), six studies included participants with MCI and one included participant with Semantic Dementia. The study settings ranged from the participants own homes, nursing homes, local community centre, memory clinics, hospital and a research unit. The studies took place in the following locations: UK, The Netherlands, France, Belgium, Germany, USA, Canada, Australia, Taiwan and Japan.

11 studies utilised a within-subjects design, four used between-subjects and eight used mixed. Full details can be seen in appendix 1.5.

Risk of bias in studies

All 23 papers were rated using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (Kmet et al., 2004) tool described and full results can be found in appendix 1.3. All papers in the study were of 'high' quality.

Results of individual studies

A summary of the results can be found in table 2 and a full data extraction table can be found in appendix 1.5. The studies are grouped according to the nature of the learning task and comprise the following categories: word-list/word learning tasks, face-name associations, picture naming, ADLs and cognitive tasks.

Within the synthesis that follows, 'standard EL' refers to training where participants were discouraged from guessing and told the answer during learning, making errors less likely. Within the reviewed studies, both the terms 'errorful' learning and 'trial and error' learning are included to indicate learning whereby the participant has been encouraged to guess the answer until they get it correct, which can result in errors made during learning. Additionally, four of the studies induced an error if the first response was correct. Although three of these used the term 'errorful' learning, one used 'trial and error' learning. Therefore 'trial and error' learning can be conceptualised as a type of 'errorful' learning.

Table 2: Summary of the reviewed studies and findings

Author(s), year, region	**Aims**	**Main outcome measure(s)**	**Main findings**	**Quality rating**
		Word list/word learning tasks		
1.Akhtar et al., 2006, UK	Compare EL to EF for people with MCI. Explore if people with MCI are aware of the benefits of EL.	Number of target words on a word list recalled (out of 10).	Free recall MCI group recalled fewer words than controls $F(1, 30)= 9.23$, $p = .05$ Both groups recalled more words in the EL condition $F(1, 30) =34.12$, $p <.05$ More words recalled across trials $F(2, 60)= 61.21$, $p <.001$ Both groups more confident in their ability to remember the words in the EL condition over EF; MCI: $F (1, 30) = 12.64$, $p< .01$). Insufficient data to calculate effect sizes (ES).	High
2. Callahan & Anderson, 2019, Canada	Compare EL and TEL under lexical and conceptual conditions in people with MCI.	Proportion of words learned from a word list (out of 9).	Free Recall More words remembered in the EL phase compared TEL $F (1, 11) =5.824$, $p=.025$, $\eta p^2=0.209$. No difference in proportion of words remembered in the conceptual group vs lexical $F(1,11)=0.023$, $p=.881$ 24 hours later no difference between the EL and TEL conditions $F(1,11)=0.016$, $p=.901$ Insufficient data to calculate ES for non-significant results.	High

3. Hochhalter et al., 2005, USA	Evaluate whether SR is more effective than expanding, random, uniform massed, or uniform distributed rehearsal.	Study 1 Number of participants able to recall name of a pill after a delay and the mean % error during training. Study 2 Number of participants able to recall a non-verbal task.	Study 1 No difference between the 5 conditions in long-term retention Q=5.2, $p > .05$. SR led to more errors during learning than expanding and random rehearsal. Study 2 3/4 participants could retain the non-verbal sequence, regardless of learning condition. No difference in number of errors made during training between the 5 conditions $Xr^2 = 5:4$; $p > 0.05$. Insufficient data to calculate ES.	High
4. Lubinsky et al., 2009, Canada	Compare the effects of EL and EF and experimenter-provided (EP) and self-generated (SG) learning, on recall, recognition and word-stem completion.	Proportion of words correctly recalled during a word list learning task (12 max per each condition). Four conditions: EL-SG, EL-EP, EF-SG & EF-EP.	Free recall Fewer errors in EL than EF in trials 1 & 2, $F(1, 36) = 7.03$, $p = .01$, $\eta2 = .17$, $F(1, 36) = 14.67$, $p < .001$, $\eta2 = .29$. Cued Recall Fewer errors in EL than EF $F(1, 36) = 87.29$, $p < .001$, $\eta2 = .70$ and SG was better than EP $F(1, 36) = 28.88$, $p < .001$, $\eta2 = .45$. In EL conditions, cued recall resulted in fewer errors when SG than EP $t(37) = 5.92$, $p < .001$, $\eta2 = .49$. No such effect in the EF condition. Recognition Recognition better in EL than EF $F(1, 36) = 16.07$, $p < .001$, $\eta2 = .31$.	High

5. Mimura & Komatsu, 2010, Tokyo	Evaluate whether VC leads to better learning than EL without fading (ELWF), category-generation or target selection, in people with AD or amnesic syndrome.	Number of correct responses on a word-pairs task.	Free recall In the AD group, the EL conditions (VC&ELWF) resulted in less errors than the EF, Wald X^2= 10.25, P < 0.001), but no difference between VC and EL. Cued recall In the AD group, EL (VC&ELWF) resulted in less errors than EF, Wald X^2 = 6.60, P < 0.01), but no difference between VC and EL. No significant benefit of effortful over effortless. Insufficient data to calculate ES.	High
6. Roberts et al., 2018, Wales	Evaluate whether EL learning leads to better learning than EF learning in people with Amnestic MCI.	Number of words recalled on a word-list learning task (max. 12 words per condition).	Free recall Participants remembered more words in the EL condition than EF t (18) = 2.59, p = .019, $\eta 2$= 0.3. Cued recall Participants remembered more words in the EL condition than EF t (18) = 3.45, p = .003, $\eta 2$= 0.4. In both EL and EF conditions, participants remembered significantly more words in the cued condition (t (18) = -5.85, p < .001, $\eta 2$=0.7) than free recall (t (18) = -4.60, p = .000, < .001, $\eta 2$= 0.6). Recognition No significant difference between EL and EF in recognising the target words t (18) = 1.79, p = .091, $\eta 2$= 0.2. However, EL conditions resulted in more accurate identification of previously unseen words t (18) = 8.78, p < .000, $\eta 2$= 0.8.	High

Face-name associations				
7. Bier et al., 2008, Canada & Belgium	Compare efficiency of EL, SR and VC in increasing learning of face– name associations in early AD. Compare these with TEL learning.	Proportion of errors produced on a face-name association task.	Learning AD group produced more errors than controls in all conditions (Mann-Whitney U test *ps*< .01). AD group produced significantly more errors during TEL than with the 3 EL conditions during learning (Wilcoxon's Z = 23.41; p <.001). Immediate recall All learning conditions, including TEL, were efficient (free recall: Wilcoxon's Zs between 22.4 and 22.8, ps< .005; total score combining free and cued recall: Wilcoxon's Zs of 23.41, ps< .001; recognition: Wilcoxon's Zs between 22 and 23.1; ps< .01). However, there was no difference between them. Delayed recall Delayed recall was poorer than immediate (Wilcoxon's Z, ps= .01). There were no differences between the conditions on combined free and cued recall or recognition (Wilcoxon's Z, ps>10). Insufficient data to calculate ES.	High
8. Dunn & Clare, 2007, Wales	Explore whether people with AD can learn previously familiar and novel face-name associations.	Number of face-name associations correctly named and number of errors.	Across all conditions Participants were able to learn the face-name associations F (1, 9) = 64.579, p <.001. More famous faces were learned than novel faces, F (1, 9) = 7.408, p< .05.	High

	Explore whether VC and paired associates, which are ‘errorless’ and target selection or forward cueing, which are ‘errorful’ are most effective.		No significant interactions between learning intervention and type of recall (free or cued). Comparison between conditions No significant difference between the 4 learning conditions, $F(3, 27) = 2.458$, ns. Effortful vs effortless Only significant effect for novel faces within the cued recall condition whereby effortful was more effective than effortless $F(1, 19) = 2.567$, $p < .05$. No effect of reducing errors. Insufficient data to calculate ES.	
9. Haslam et al., 2006, UK	Study 1 Understand the benefit of EL over EF learning across a range of knowledge levels. Study 2 Understand if familiarity-based judgments were possible within an EL learning model and if so, evaluate the effectiveness of EL over EF. Study 3 Ascertain whether this effectiveness of EL learning	Studies 1-3 Accuracy of face-name-occupation associations.	Study 1 The “EL> EF” outcome occurred with greater frequency than EL≤EF $X^2(2) = 8.92$, $p<.05$. EL learning was more beneficial when low-level information was being retrieved. Study 2 Overall performance reduced between levels 1 and 3 at immediate and delayed recall. No significant difference in performance accuracy between EL and EF conditions at any knowledge level. Study 3 Performance was better under EL conditions than EF $F(1, 6) = 8.11$; $p< .05$; $r= 0.6$.	High

	over EF holds for people with mixed dementia.		Participants performed significantly better at level 1 than level 2 t (1, 6) = 6.0, p< .01 and level 3 t (1, 6) =7.12, p< .001. The difference between performance in the EL condition compared to the EF condition only held at levels 2 and 3 F(2, 12)=14.15, p< .001 Insufficient data to calculate ES.	
10. Haslam et al., 2011, UK NB experiment 1 & 2 did not include dementia/ MCI so are not included	Explore whether PWD show improved memory performance in SR conditions over that of EL and TEL.	Accuracy on a face-name association task during cued recall.	Participants made no errors during naming in the EL condition and made more errors during TEL (M = 33.20, SD = 14.38) than SR (M = 8.60, SD = 5.03); t (14) = 8.06, p < .001. Naming accuracy was better in the SR condition than TEL t (14) = 4.40, p = .001, r = .76. No difference between SR and EL conditions t (14) = 1.60, p = .13. For cued recall, SR was better than EL conditions, t (14) = 2.42, p = .03, r = .54.	High
11. Jean et al., 2010, Canada	Evaluate the efficacy of EL combined with SR for people with amnestic MCI (MCI-A) .	Number of names correctly recalled in a face-name association task. Novel (episodic) and famous (semantic) face-name associations (episodic).	No significant difference between the EL and EF groups. Both groups performance improved over time with both episodic (F (2, 35) = 49.390, p<.001) and semantic (F (2, 35) =11.569, p<.001) material. Insufficient data to calculate ES.	High

12. Metzler-Baddeley & Snowdon, 2005, UK	Examine whether EL is a more successful training strategy than EF for people with AD.	Number correctly recalled names of both novel (face-name associations) and familiar (object naming) materials.	For free recall of both novel and familiar material, participants recalled more in EL compared to EF $t(3) = 2.5$, $p < 0.05$, $\eta2=0.7$. For familiar material and novel material separately, participants recalled more in EL than EF $t(3) = 2.6$, $p < 0.05$ (novel), $\eta2=0.7$, $t(3) = 2.5$, $p < 0.05$ (familiar), $\eta2=0.7$.	High
13. Ruis & Kessels, 2005, The Netherlands	Evaluate effectiveness of EL in participants with moderate-severe dementia, on a face-name association task.	Number of correct face-name associations.	There was a significant Trial x condition interaction $F(2, 7) = 6.02$, $p=0.03$. Significantly more correct face-name associations in the EL learning condition than EF but only in trial 2 $t(9)=3.50$, $p=0.007$). No significant difference for delayed recall. Insufficient data to calculate ES.	High
Picture naming				
14. Jokel & Anderson, 2012, Canada	Explore whether EL leads to greater learning improvements than EF and active learning over passive.	Proportion correct on a picture naming task from the Peabody Pictures set.	Naming test EL was more effective for name learning than EF $F(1, 6) = 25.31$, $P<.002$, $\eta2= .81$. This increased over the sessions $F(11, 66) =5.08$, $p< .006$, $\eta2= .46$. Recognition There was no significant benefit of EL $F(1, 5) = 2.192$, $p< .20$) over EF or active over passive learning $F(1, 5) =0.625$, $p <.47$. There was also no interaction. At 1 month f/u, the maintenance of naming was larger after EL than EF $F(1, 6) = 16.98$, $p< .006$, $\eta2= .74$.	High

15. Noonan et al., 2012, UK	Evaluate whether EL and EF is equally effective when relearning the names of previously known and well-used everyday items and animals.	Proportion of items correctly recalled from a picture of the item.	At 1 week post-therapy, both EL and EF therapies improved item naming more than no treatment t (7) =5.1, two-tailed p>.001; t (7) =5.3, p<.001. However, there was no difference between EL and EF or at week 5 post-therapy. For the EL condition, naming improved at week 1 and 5, compared to baseline t (7) = 6.3, p <001; t (7) = 4.0, p=.005.However, performance was slightly poorer at week 5 than week 1 t (7) =3.2, p <.014. Similarly, for the EF condition, naming significantly improved at week 1 and 5, compared to baseline t (7) = 5.4, p< .001; t (7) = 4.8, p<.002. However, there was no decline in performance between the time points in the EF condition. Insufficient data to calculate ES.	High
ADL tasks				
16. Bourgeois et al., 2003, USA	Compare efficacy of SR and a modified Cueing Hierarchy (CH) for teaching PWD to use an external memory aid for a particular purpose.	Goal outcomes in relation to ADLs.	Participants were more successful in achieving their goals when using SR compared to CH, F (1, 24) = 4.99, P < 0.035. No difference in the number of trials and sessions it required to master a goal between the two conditions. More goals maintained in SR group compared to CH group at 1-week follow-up (Z=-2.33, P < 0.02, r =0.3) and 4 months (Z= 0.20, P < 0.05, r = 0.1).	High
17. Bourgeois et al., 2016, France.	Evaluate the effectiveness of TEL, EL and Modelling with SR (MR) on the relearning of ADLs in participants with mild to moderate AD.	ADL task performance	Participants' performance improved across all groups across all learning sessions F (1, 49) =97.64, p<0.001. No significant difference between the 3 learning conditions F (2, 49) =.93, p=.4.	High

			Improved performance maintained at 1 month follow-up F (1, 49) =2.92, p=.09. No difference in performance between the 3 learning conditions at 1 month follow up F (2, 49) =1.43, p=.25. Insufficient data to calculate ES.	
18. Dechamps et al., 2011, The Netherlands	Observe whether EL, learning by modelling (LM) or TEL improve most the (re)learning of skills related to ADL in different dementia severities.	Implicit learning: the ability to carry out the specific ADL task Explicit learning: Cue card sorting	The EL and LM learning conditions improved implicit (procedural) performance when carrying out the ADL most over the 6 sessions. For the LM condition, the baseline to 1 week f/u showed a 33.0% improvement, CI95% [6.1-60], P=.01 and 30.8%, CI95% [5.8-55.9], P= .009 for the baseline to 3 week f/u. There was significant progression over time (F (7, 91) =8.7, P < .001, ηp2= 0.42. For the EL condition, the baseline to 1 week f/u showed a 22.2.0% improvement, CI95% [6.6-37.8], P=.01 and 24.2%, CI95% [7.7-40.8], P= .002 for the baseline to 3 week f/u. There was significant progression over time (F (7, 91) =7.0, P < .001, ηp2= 0.35. For the TEL condition, the baseline to 1 week f/u showed a 12.2%, CI95% [1.7-22.7], P=.015 and 6.8% (CI95% [-8-21.5]) at the 3-week f/u. There was significant progression over time F (7, 91) =5.8, P < .001, ηp2= 0.3. The LM and EL conditions were more effective for the implicit learning task (procedural) compared to TEL, with a mean difference of 15.2% CI95% [6-24.4], P= .002 (LM) and 9.6% CI95% [-1.2-20.3], P=.09 (EL).	High

			No differences between the 3 learning conditions for the explicit learning tasks (ordering of instruction cards).	
19. Lin et al., 2010, Taiwan	Evaluate the effectiveness of SR vs Montessori-based activities for eating difficulty in PWD.	Edinburgh Feeding Evaluation in Dementia (EdFED) and assisted feeding scores.	Both SR and Montessori-based had significantly lower EdFED scores (reduced feeding difficulties) than controls ($P<0.05$) and required less feeding by carers ($P<0.05$; $P<0.01$). The SR group had better nutritional status at 8 weeks than controls ($P<0.01$). However, the Montessori group had poorer nutritional status at 8 weeks than controls ($P<0.01$). Insufficient data to calculate ES.	High
20. Voigt-Radloff et al., 2017, The Netherlands	RCT comparing EL to TEL on the carrying out of ADL's in people with mild-moderate dementia.	ADL task performance as assessed by the Core Elements Method (CEM).	Both EL and EF groups showed better task performance from baseline to week 16: standardised effect size (95% CI): task A, 0.61 (0.37–0.85); task B, 0.47 (0.23–0.71)) and to week 26 (task A, 0.41 (0.17–0.64); task B, 0.26 (0.03–0.50)). There was no time by group interaction.	High
Cognitive tasks				
21. Kessels & Hensken (2009), The Netherlands	Compare EL to EF in adults with mild-moderate/severe dementia, and controls	Number of steps completed without assistance during a problem-solving task from the Dysexecutive Syndrome (BADS) battery.	<u>Immediate</u> Participants with mild-moderate dementia performed worse than controls ($p = 0.022$) and those with severe dementia performed worse than the mild-mod group ($p = 0.001$). EL was more effective than EF, $F [1, 54] = 6.8$, $p = 0.012$. Moderate effects of EL were found in the mild-moderate dementia group a ($d = 0.52$) and severe dementia ($d = 0.31$).	High

			<u>Delayed</u> Large effects of EL were found in the mild-moderate dementia group (d = 1.61) and severe dementia (d = 1.0).	
22. Ozgis et al., 2009, Australia	Explore effectiveness of SR for improving Prospective Memory (PM) function in adults with MCI.	Correct responses made on a PM measure using a Virtual Week boardgame.	For MCI, SR significantly improved their performance on the PM boardgame task $F(1, 66) = 19.67$, $p < 0.001$. No difference between the control and MCI group's performance during the SR condition. During the standard rehearsal condition, the MCI group were poorer than controls $d = 0.32$.	High
23. Schmitz et al., 2014, Canada	Compare effectiveness of EL and EF learning in a perceptual-motor task in people with AD.	<u>Learning task</u> Number of errors made during a perceptual-motor learning task. <u>Serial Reaction Time (SRT) task</u> Median reaction time (RT) and number of errors.	<u>Learning task</u> Participants in both groups were quicker in the second learning task than the first $F(1, 24) = 0.78$, $p = 0.39$, $\eta p2 = 0.03$. AD group produced more errors than controls $F(1, 24) = 24.45$, $p < 0.001$, $\eta p2 = 0.51$ Significantly less errors were made in the EL condition than EF in both groups $F(1, 26) = 274.60$, $p < 0.001$, $\eta p2 = 0.91$. <u>SRT task</u> In the AD group, for the EL condition RTs were longer in the transfer blocks compared to the sequence blocks ($p = 0.005$) showing a learning effect. Effect not present for EF condition.	High

EL, Errorless Learning; EF, Errorful Learning; TEL, Trial and Error Learning; SR, Spaced Retrieval; VC, Vanishing Cues; ES, effect sizes.

Synthesis

Six out of the 8 studies which used an SR approach combined EL principles with the increasing intervals employed during SR. However, during Hochhalter et al's (2005) SR condition, participants were asked to guess if they did not know, limiting the 'errorless' nature of the intervention. Additionally, Lin et al's (2010) description of the SR procedures were limited. Only 3 out of the 23 studies used a VC approach, all of which included EL principles alongside the gradual removal of cues.

Word List and other word learning tasks

Five studies utilised a word-list learning task (Akhtar et al., 2006; Callahan & Anderson, 2019; Lubinsky et al., 2009; Mimura & Komatsu, 2010; Roberts et al., 2018) and participants in Hochhalter at al.'s (2005) study had to remember names of pills. All, excluding Hochhalter et al. (2005), utilised a standard EL protocol and compared this to EF. However, Lubinsky et al. (2009) also included an effortful EL condition and Mimura and Komatsu (2010) included a VC condition. Hochhalter et al. (2005) compared SR to four other conditions; expanding rehearsal, random rehearsal, uniform massed rehearsal and uniform distributed rehearsal. Three of these studies utilised a delayed recall condition.

The above studies found standard EL to be more effective than Effortful Learning (EF) regardless of whether the study population were those with MCI (Akhtar et al., 2006; Callahan & Anderson, 2019; Lubinksy et al., 2009; Roberts et al., 2018) or AD (Mimura & Komatsu, 2010). However, Callahan & Anderson (2019) did not find a significant benefit of standard EL over Trial and Error (TEL) after a 24-hour delay. The three studies which included both free and cued recall found EL to be better than EF across both conditions (Mimura & Komatsu, 2010; Lubinsky et al., 2009; Roberts et al., 2018). Roberts et al. (2018) also found that for both standard EL and EF, cues provided a significant benefit over free recall and Lubinsky et al. (2009) observed self-generated cues to be more effective than those provided by the experimenter. Additionally, Mimura and Komatsu (2010) found no difference in performance depending on the amount of effort required during the learning task.

Hochhalter et al. (2005) found no difference between any of the conditions in terms of long-term retention of the pill name but found that those in the SR condition made more errors during learning expanding and random rehearsal.

Out of these five studies, effect sizes were only available for Lubinsky et al. (2009) (small range) and Roberts et al. (2018) (large).

These results indicate that all studies which utilised a standard EL procedure during a word learning task found standard EL to be more effective than EF for people with dementia or MCI. The study utilised an SR intervention did not find this effect but as they asked participants to guess the answer if they did not know, the errorless nature of the intervention is reduced. The effect sizes for these findings ranged from small-large but were only available in two out of the six studies, thus the magnitude of the benefit of standard EL over EF is unclear. Also, the small sample sizes utilised in the studies mean the generalisability of the results is limited. These studies also comprise of 'artificial' tasks which have little applicability within real-life settings.

Face-name associations

Seven studies examined the learning of face-name associations (Bier et al, 2008; Dunn & Clare, 2007; Haslam et al., 2006; Haslam et al., 2011; Jean et al., 2010; Metzler-Baddeley & Snowdon, 2005; Ruis & Kessels, 2005). Three of these studies compared standard EL to EF conditions (Haslam et al., 2006; Metzler-Baddeley & Snowdon, 2005; Ruis & Kessels, 2005) and one compared SR to EF (Jean et al., 2010). Additionally, Dunn & Clare (2007) compared two conditions of EL (effortless and effortful) to two conditions of EF (effortless and effortful). The effort level was related to the cognitive demands placed on the participants during the study tasks. Three other studies compared standard EL to SR and VC (Bier et al., 2008) and standard EL to SR and TEL (Haslam et al., 2011).

For studies comparing standard EL to EF, Haslam et al. (2006) conducted a 3-part study and found that standard EL was significantly better than EF for participants with probable AD, particularly when concerning low levels of knowledge during a face-name-occupation association task. However, in their 2nd study which included a two-alternative forced-choice task, they did not find this effect. However, only 2 participants were involved. For their 3rd study, which was the same as their 1st but with participants with AD or Vascular Dementia, they again found better performance in the standard EL condition compared to EF but only for levels 2 and 3 (discrimination between the two occupations (educator or musician) and discrimination) between whether the person is a primary/secondary teacher and a pianist or saxophonist). Ruis and Kessels (2005) and Metzler-Baddeley and Snowdon (2005) also found that participants with AD were able to recall more face-name associations correctly under standard EL conditions than EF. This was the case for both novel and familiar material (Metzler-Baddeley & Snowdon, 2005).

In addition to comparing standard EL to EF, Dunn and Clare (2007) compared effortful vs effortless for each condition in relation to the learning of novel and famous faces. However, although participants in all groups were able to learn the face-name associations, there was no significant difference between any of the 4 conditions. There was also no significant interaction between learning intervention and type of recall (free, cued or recognition). In terms of the amount of effort required during learning, there was only an effect within the cued recall condition of novel faces whereby effortful was more effective than effortless. Additionally, Jean et al. (2010) found no significant difference between SR and EF in people with MCI-A. Instead, both groups improved significantly over the course of the 6 sessions.

In contrast to the above findings, Bier et al. (2008) found that TEL resulted in significantly more errors than standard EL, SR and VC in terms of naming accuracy in people with AD. Likewise, Haslam et al. (2011) found the same results (moderate effect size) in PWD with varied aetiologies when comparing standard EL and SR to TEL. In Bier et al's (2008) study, all conditions including the EF conditions were effective during immediate recall but with no significant difference between them. They also found that participants performed more poorly during delayed recall than immediate and there were no differences between the conditions on combined free and cued recall or recognition. In Haslam's (2011) study, although they found no significant difference between SR and standard EL during free recall, SR was significantly better than standard EL during cued recall, with a moderate effect size.

These results indicate mixed findings regarding the superiority of standard EL, including SR and VC, in the learning of face-name associations. Although four studies found standard EL, and one study using SR, to be more effective than EF, the others did not find this effect. Three studies comprising a mix of EL, SR and VC found no benefit of standard EL over EF. It is important to note that two of the studies which did find superiority of standard EL over EF had extremely small sample sizes (<10). Effect sizes were only available for two of the studies and indicated a moderate effect, which again limits an understanding of the size of the effect.

ADL tasks

Five studies used tasks related to ADL as the learning task (Bourgeois et al., 2003; Bourgeois et al., 2016; Dechamps et al., 2011; Lin et al., 2010; Voigt-Radloff et al., 2017). Both standard

EL (Dechamps et al., 2011; Voigt- Radloff et al., 2017) and SR (Bourgeois et al., 2003; Bourgeois et al., 2016; Lin et al., 2010) were used. Whilst Dechamps et al. (2011) found both standard EL and learning by modelling significantly more effective (small-moderate effect size) than TEL for people with AD during an implicit (procedural) learning task, Voigt- Radloff et al. (2017) found that both the standard EL and EF groups (mild-moderate dementia) showed significantly better ADL task performance from baseline to week 16 with small-medium effect sizes. However, no difference in performance between the groups were found.

Two studies compared SR to approaches other than TEL. Bourgeois et al. (2003) found that PWD were more successful in achieving their ADL goals when trained using SR compared to a Cueing Hierarchy (a systematic series of cues of increasing strength based on the individual's response to each type of cue) and this remained significant at 1 week follow-up. However, there was no significant difference in the number of trials or sessions it required to master a goal. In relation to eating behaviour in PWD, Lin et al. (2010) found both SR and Montessori-based activities (i.e. breaking down the tasks involved in eating, hand-eye coordination and differentiating between edible and non-edible objects) reduced feeding difficulties more than controls (routine eating activity). Although this study did not compare the two active interventions, the SR group had significantly better nutritional status at 8 weeks than controls whereas the Montessori-based groups was significantly poorer.

These results indicate mixed findings regarding the superiority of EL over EF. Out of the three studies which compared EL to EF, only one found EL to be more effective with small-moderate effect sizes. However, the studies using SR found this approach to be more effective than a Cueing Hierarchy for achieving ADL goals and resulted in better nutritional status than Montessori-based activities for an eating intervention. Although these studies utilised ADL tasks, the tasks were quite different between studies and thus we are unable to make generalised conclusions. However, ADL tasks are perhaps the most important due to having more ecological validity and having the potential to have a positive impact on the lives of people with dementia/MCI. Therefore, although the evidence is varied, more research is required in this area.

Picture naming

Two studies used picture naming as the learning task (Jokel & Anderson, 2012; Noonan et al., 2012). Whilst Jokel & Anderson (2012) found naming accuracy during free recall better in people with semantic dementia in the standard EL condition compared to EF during learning and 1/3-week follow-up, Noonan et al. (2012) found both conditions significantly improved learning in people with AD from baseline to 5-week post-treatment, with no difference between them at 1-week post-treatment. They also found a reduction at week 5 for standard EL but not EF. There was no advantage of EL over EF for recognition of the pictures.

These results indicate that the evidence available for the use of EL in picture naming tasks is very limited. Additionally, as both studies comprise participants with different conditions (Semantic Dementia and AD), it is difficult to compare the results.

Cognitive tasks

Cognitive tasks were used in three papers with executive function (Kessels & Hensken, 2009)), prospective memory (Ozgis et al., 2009) and perceptual motor tasks being used (Schmitz et al., 2014). Schmitz et al., (2013) found standard EL resulted in better accuracy than EF for people with AD during a perceptual motor task whilst Kessels & Hensken (2009) found standard EL to be significantly more effective than EF during an executive function task with adults with mild-moderate and severe dementia (moderate effect sizes). They also found large effect sizes for the benefit of EL over EF after a delay of 1-3 days. Ozgis et al. (2009) found similar results for SR during a perceptual motor task whereby adults with MCI were significantly more effective learning via SR compared to standard rehearsal.

Although each of the three studies utilising cognitive tasks found standard EL, and SR in one study, to be superior to EF, each study looked at very different types of cognitive task. They also involved participants with different conditions including AD, dementia (range of severity) and MCI. Therefore, although the evidence appears promising, it is too limited to draw any conclusions.

A summary table detailing significant results by length of recall and type of recall can be found in appendix 1.6.

Discussion

This is the first systematic review exploring the effectiveness of EL using a range of primary outcomes for individuals with dementia or MCI. The results indicate that EL is an effective cognitive training approach for word-list learning, when tested immediately and after a delay, indicating that the learning is maintained over time. However, the findings for other outcomes were less certain, with equivocal learning in both EL and EF conditions. This highlights that

EL appears to be most effective when used during highly controlled 'artificial' research tasks and thus further research is required to investigate whether this learning approach is effective for 'real-world' tasks which are likely to have a larger impact upon the lives of people with dementia or MCI.

Whilst most of the studies provided evidence supporting the superiority of EL over EF there were conflicting results from a limited number of studies. Interestingly, all studies which did not find EL to be superior to EF found that the information was learned equally in all conditions. This illustrates that learning is possible for PWD and MCI, but EL is not always superior to EF. It is possible that the small sample sizes in all but one of the studies (Voigt-Radloff et al., 2017) which failed to find superiority of EL over EF may have made it difficult to establish differences between the conditions. However, the largest and only high-powered RCT did not find a difference between EL and EF in relation to performance on ADLs (Voigt-Radloff et al., 2017). It is also important to note that the sample sizes were small within the studies which did find a significant result. Unfortunately, due to many studies not providing effect sizes and being unable to be calculated post-publication due to insufficient data, the effect sizes for the non-significant findings cannot be compared to the significant findings.

A possible explanation for the equivocal learning between EL and EF in some studies may be because the EL interventions may not have been fully 'errorless'. One study encouraged participants to guess if they did not know the answer, which limited the 'errorless' nature of the intervention (Hochhalter et al, 2005) and two others found that participants made errors during learning in the EL condition (Dunn & Clare, 2007; Bier et al, 2008). Unfortunately, the other studies did not provide error rates and so it is difficult to ascertain how 'errorless' these interventions were. However, the challenge associated with developing a truly 'errorless' intervention has been highlighted previously (Clare & Jones, 2008). This highlights a challenge in developing 'real-world' interventions that reduce the likelihood of errors during learning.

EL was found to be superior to a Cueing Hierarchy and Montessori-based learning in relation to performance on daily living tasks, but the evidence was limited. Only one study found an EL approach (SR) to be less effective than another condition (Hochhalter et al., 2005) and as discussed previously, their SR protocol was not 'errorless'.

Although this review excluded papers which only compared EL to other approaches which limit chance of errors, including SR and VC, five papers compared these conditions in addition to EF. Four of these studies found no difference between the different EL conditions. However, Haslam et al. (2011) found SR to be significantly better for naming accuracy during cued recall than EL.

Overall, it can be concluded that EL is effective for the learning of words, under both free and cued recall conditions and immediately and after a delay. The only study in this review which utilised a word learning task but did not find EL to be superior to EF did not include a truly 'errorless' paradigm (Hochhalter et al, 2005). The positive findings applied to both MCI and AD populations, although the evidence for the latter was more limited. The effectiveness of EL for the other learning tasks is less clear with ambiguous findings regardless of population, type of 'errorless' learning, and form/point of recall.

A key limitation of the review findings is that most of the studies utilised artificial tasks and out of those which involved ADLs, only one explored the effect of the learning task on the participants' need for assistance with ADLs and other outcomes such as Challenging Behaviour, finding no significant effect (Voigt-Radloff et al., 2017). The lack of generalisation as a constraint of EL has been highlighted previously (Clare & Jones, 2008). As mentioned previously, it is necessary for future research to explore more ecologically valid outcomes to aid our understanding of whether EL can be used to improve the daily life of PWD or MCI.

Additionally, although many of the studies tested learning after a delay, the delay periods were usually short, with only five of the studies which tested after a delay having longer than a 1-month follow-up. Studies providing longer term follow up periods are therefore required to observe whether this learning is maintained. However, positively, only two of the studies only used cued recall without testing free recall, demonstrating that nearly all the studies tested learning in the form that the people were going to need to use it.

Limitations and future research

Overall, the methodological quality of the studies in this review was rated as 'high' which contrasts previous reviews which looked at cognitive rehabilitation for dementia more generally and found most studies to be of low quality (Bahar-Fuchs et al., 2013; Bahar-Fuchs et al., 2019). This is despite most of the studies in this review encompassing small sample sizes and few reporting effect sizes. It is likely that using a tool which is relevant to any study design may have reduced the specificity of the tool and using more specific tools may have been more sensitive to these methodological issues which have impacted upon the final quality rating of some of the papers.

As mentioned above, most of the included studies had small sample sizes meaning they were low in power and lack generalisability. The absence of reported effect sizes in more than half of the papers makes the benefit of EL over other approaches difficult to quantify. Additionally, over half the studies did not include estimates of variance meaning that the precision of the estimated differences cannot be ascertained. These methodological issues mean that the results of this review should be interpreted with caution and it is important that future studies rectify this through using larger samples, reporting effect sizes and estimates of variance.

A further limitation of this review is that studies which compared EL to another approach alone which minimises errors, were not within the scope of this review. Therefore, the relative effectiveness of the different EL approaches requires further exploration.

Clinical implications

Cognitive rehabilitation is important for maintaining independence and improving quality of life for PWD, which could play a central role in the drive towards keeping individuals at home or in homely settings for as long as safely possible, as recommended by the National Dementia Strategy (Scottish Government, 2017). This review has illustrated that PWD/MCI can learn using EL strategies. However, most of the tasks used were artificial tasks which are unlikely to have a direct impact upon the quality of life of the individuals. Although there were some ambiguous findings as to whether EL is advantageous over EF for the (re)learning of ADL tasks, there is sufficient evidence to suggest that errorless approaches should be considered when clinicians are planning interventions, particularly as ‘in principle’ reducing errors during learning should be helpful for people with memory impairments.

Conclusions

The synthesising of these studies highlighted that EL is an effective cognitive training strategy for PWD or MCI for word learning tasks. However, there is ambiguity as to whether EL is more effective than TEL approaches for learning of face-name association, picture naming, ADLs or other cognitive tasks. Future research requires larger sample sizes to increase power and better reporting of effect sizes to understand the magnitude of the superiority of EL over TEL. More studies investigating the effectiveness of EL for more ecologically valid tasks which may improve the quality of life of PWD or MCI are required.

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Chapter Two: Major Research Project

The Scottish memory aid survey: Recommendations made by healthcare professionals working with clients with dementia and mild cognitive impairment.

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Prepared in accordance with the author requirements for *Neuropsychological Rehabilitation* (see Appendix 1.1)

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Plain English Summary

The Scottish memory aid survey: Recommendations made by healthcare professionals working with clients with dementia and mild cognitive impairment.

Background

Memory impairment affects most people with a diagnosis of dementia, initially causing difficulties with memory for recent events (retrospective memory), as well as remembering to do things in the future (prospective memory). Memory aids can be used to help people remember to do things which can improve quality of life and independence. Electronic memory aids have been found to increase remembering in people with brain injuries; however, they are used less often by people with dementia.

Key aims

To explore what technological and non-technological memory aids healthcare professionals working within Older People's Community Mental Health Services in Scotland are recommending to people with Mild Cognitive Impairment impacting on memory or Dementia.

To investigate what the barriers are to the use of technological memory aids for people with Mild Cognitive Impairment or dementia, from the viewpoint of healthcare professionals working with this population in Scotland.

Method

138 healthcare professionals working within Older People's Services in Scotland were recruited. Participants were recruited from Older People's Community Mental Health Teams in Scotland with the survey being distributed through the respective NHS team leads. The survey was also distributed via the Division of Clinical Psychology Faculty of the Psychology of Older People's Scottish network and was advertised on a Private Facebook group for Clinical Psychologists working with Older People in the UK. The survey was also advertised via Twitter, through the Royal College of Nursing Scotland and the Royal College of Occupational Therapists Older People's section.

The survey was comprised of four sections; demographic questions, a memory aid checklist of different memory aids the health care professionals may recommend to their clients, questions looking at what the health care professionals believe are the barriers to assistive technology use for their clients and a section regarding the health care professionals' own familiarity with and use of technological and non-technological memory aids and their beliefs about the utility and effectiveness of such memory aids for people with dementia or Mild Cognitive Impairment.

Results

The results highlighted that the healthcare professionals recommend non-technological memory aids more frequently than technological reminders. It is also found that most of the healthcare professionals surveyed believe technological reminding tools can be effective for people with dementia or Mild Cognitive Impairment and feel confident in recommending such tools to clients. However, the majority of the professionals believe current reminding technology is inaccessible and difficult to learn for this group.

Conclusions

This study indicates that healthcare professionals working with people with dementia or Mild Cognitive Impairment recommend non-technological memory aids and strategies to their clients more frequently than technological reminding tools. It also highlighted the main barriers to the use of technological memory aids perceived by the professionals which were that their clients would find it difficult to learn how to use new technology and they prefer writing things down. The results indicate that more research is needed to explore the best design of technological memory aids for people with dementia or Mild Cognitive Impairment and to examine how effective technological reminding tools are for this population.

Key References

Jamieson, M. (2016). *Investigating assistive technology to support memory for people with cognitive impairments*. PhD thesis, University of Glasgow. https://eleanor.lib.gla.ac.uk/record=b3176612

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Abstract

Background

Impairments in memory are common in those living with dementia. This can have a negative impact on individuals' everyday functioning, quality of life and ability to live independently. Electronic prospective memory aids have been found to increase remembering in other clinical populations, though evidence on the use of such tools for people with dementia or Mild Cognitive Impairment is limited.

Aims

This study aimed to explore what memory aids healthcare professionals working within Older People's Community Mental Health Services in Scotland are recommending to people with Dementia or Mild Cognitive Impairment. It also looked at the barriers to using technological memory aids from the viewpoint of health care professionals working with this population.

Methods

Participants (N=138) were NHS healthcare professionals working within Older People's Community Mental Health Services in Scotland and Alzheimer Scotland's Dementia Link Workers. Each participant completed an online survey looking at what memory aids they recommend to people with Mild Cognitive Impairment or Dementia and what they think the barriers are to using technological memory aids with this population.

Results

The healthcare professionals recommended non-technological memory aids/strategies more than technological tools. The most recommended strategies were leaving objects in the same place so they know where to find them and using a whiteboard or wall chart for which over 80% of the participants often recommend to clients. The most frequently recommended assistive technology was alarm clocks. Mobile phones were also recommended, but only 20.3% of professionals said that mobile phones are often recommended. The majority of the healthcare professionals surveyed believed technology reminding tools can be effective for clients with dementia or Mild Cognitive Impairment and reported feeling confident in recommending such tools. However, most also believed that their clients would have difficulty in accessing and learning to use technology as a memory aid. Additional exploratory analyses found that as the length of time working in older people's services

increased, the healthcare professionals were more likely to recommend technological reminding tools. It was also found that healthcare professionals who were more confident in using technology themselves were more likely to feel confident in recommending technology-based reminders to their clients.

Conclusion

This study highlights that healthcare professionals working with people with dementia or Mild Cognitive Impairment recommend non-technological memory aids and strategies to their clients more frequently than technological reminding tools. The main perceived barriers to the use of technological memory aids were that the professionals believed their clients would find it difficult to learn how to use new technology and that they prefer writing things down than using a technological tool. The potential benefit of training for healthcare professionals on how to actively promote the use of technological tools to improve the quality of life of people with dementia is also highlighted. Future research is required to understand the optimal design of technological reminding tools to ensure accessibility and effective use for this population.

1. Introduction

Background

There was an estimated 850,000 people in the UK living with dementia in 2014 which is projected to increase to one million by 2025 and two million by 2050, due to people living longer because of improved healthcare and living standards (Prince et al., 2014). This projected increase highlights the requirement to develop ways of supporting people with dementia to live as independently as possible for as long as possible.

Prospective Memory

Everyday life frequently involves remembering to do things, or prospective memory (PM) and is critical to successful independent living for all ages, including older people (Chasteen et al., 2001). Individuals with Alzheimer's Disease and Mild Cognitive Impairment (MCI) perform significantly worse on PM tasks compared with healthy older adults without these conditions (Spindola & Brucki, 2011). Deficits in PM can have important consequences on the daily lives of people with dementia, such as forgetting to attend important appointments or forgetting to take medication (Groot et al., 2002). PM tasks can be classified into event-based tasks (e.g., take cash out when using a cash machine), time-based tasks (e.g., a hospital appointment at 10:00am) and activity-based tasks where the trigger is the person's own past behaviour (e.g., take medication after breakfast) (Einstein &McDaniel, 1990). Einstein et al. (1995) suggested that time-based tasks are usually more difficult to remember as the passage of time must be monitored, and the remembering has to be self-initiated. PM tasks can also be categorised into pulse intentions, which need to be carried out at a precise time, and step intentions which have a less specific window of time to be accomplished (Ellis, 1988).

Carrying out PM tasks relies on a variety of cognitive functions (Fish et al., 2015). Fish et al. (2010) highlighted a cognitive hierarchy, suggesting that although memory for the intended action is a requirement for it to be carried out, this alone is inadequate to guarantee successful performance. Fish et al. (2015) specify that attentional and executive processes are also necessary for planning the intended action, and to recognise the retrieval cue, passage of time or chance to perform the intention in addition to retrieving and carrying out the intention. These processes must also compete with parallel tasks which can distract attention away from the goal (Fish et al., 2015). There are also metacognitive features of PM comprising "task-specific awareness of errors, performance evaluation, and more general insight into one's PM abilities" (Fish et al., 2015, p160).

Memory Aids

There are many types of memory aids, which can be classified into environmental or portable aids (Kapur et al., 2002). Environmental aids include wall charts, alarms and leaving objects in visible places, whilst portable aids consist of aids which are easily visible and accessible including technological devices with reminding capabilities (Caprani et al., 2006). Assistive technology for cognition includes “any technology which compensates for cognitive deficit during task performance” (Gillespie et al., 2012, p. 2).

As memory problems are a key feature of dementia, the use of non-technological memory aids in this population has been investigated in various studies. One such study investigating the use of external memory aids for individuals with Alzheimer’s disease found that portrait-style photographs and a sign with participants’ names increased room finding ability within a nursing home setting (Nolan et al., 2001). Furthermore, Bourgeois (1992) used personally significant pictures and sentences as probes to improve the quality of dyadic conversations in people experiencing moderate-severe dementia. Another study also suggests that the use of memory notebooks can lead to a reduction in emotional distress and challenging behaviour in people with Alzheimer’s Disease (Johnson, 2009). Jones et al (2021) also highlight a key limitation of non-technological memory aids in that people with dementia and memory problems are still required to “remember to remember” to make use of these tools.

Research into the use of technological memory aids for people with dementia and memory problems is in its early stages. A recent systematic review aiming to review all randomised controlled trials (RCTs) and cluster randomised trials evaluating the use of an electronic assistive device exclusively for assisting memory function in individuals with dementia found that no studies matched their inclusion criteria(Van der Roest et al., 2017). They identified that studies which were excluded because of the study design were due to them being longitudinal, non-randomised or single-subject designs, in addition to small sample sizes (Van der Roest et al., 2017). The authors suggest that the scarcity of RCTs in this area is partly because of strict governance regulations which makes obtaining appropriate ethical approval difficult for researchers. A lack of standardised terminology used in this research area was also identified as a potential issue as this makes it difficult to identify relevant studies. Nevertheless, there is evidence that technological memory aids may be useful. McGoldrick et al. (2019) used a single-case experimental design to explore the effectiveness and usability of the MindMate application, which was specifically developed to support people with Dementia. The two participants who successfully completed the intervention gave positive usability ratings and results indicated significant improvement in everyday memory performance (McGoldrick et al., 2019). Similarly, El Haj et al. (2017) found a decrease in forgetting when using Google Calendar as a reminding tool for targeted events. However, it was noted within a Systematic Review by Evans et al. (2015) that current Dementia-focused assistive technology tends to focus on ‘ease of living’ more so than ‘quality of life’.

A recent systematic review which investigated the efficacy of different PM interventions including external memory aids (combined technological and non-technological tools), for both healthy and memory-impaired older adults, found strong evidence (Hedges g=.805) supporting the efficacy of this approach (Jones at al., 2021). They also found the studies exploring the effectiveness of external memory aids to have higher ecological validity in comparison to those looking at mnemonic strategies, cognitive training or combination interventions. However, most of the studies had small sample sizes and case-series designs.

Despite the availability of ‘off the shelf’ electronic reminding devices, they appear to be used less frequently by people with dementia than other neurological conditions. Research indicates that a small proportion of people with dementia use them in comparison to those with an Acquired Brain Injury (ABI). A previous survey indicated that whilst 75% of people with an ABI used at least one technological memory aid, only 38% of those with dementia used them (Jamieson, 2016). Additionally, 25% of those with an ABI rated mobile phones as being “a lot of help” whereas less than 5% of respondents with dementia rated in this way. However, the rates of use of non-technological memory aids were high in both groups, with 96% of those surveyed with an ABI indicating their use and 90% of people with dementia. It may be that the tendency for people with an ABI in studies to be younger in comparison to those with dementia partly accounts for the difference in use of assistive technology. Moreover, Jamieson (2016) found that for participants with dementia, those who used technological tools for reminding before the onset of their memory difficulties were more likely to use electronic memory aids after their diagnosis. Additionally, those with dementia who used non-technological memory strategies were more likely to also use technology for reminding (Jamieson. 2016). The key barriers to using technological memory aids were identified as feeling incapable of using them, technology not being something they were accustomed to using and concerns that depending on technological memory aids would cause a further decline in memory (Jamieson, 2016).

Although this earlier research gathered evidence as to the prevalence of memory aid use by people with dementia, there is no research exploring what type of memory aids health care professionals working with people with dementia tend to recommend, if any. It is also undetermined as to what health care professionals perceive the barriers of using technological memory aids to be for their clients. Previous research conducted by Hart et al. (2003) revealed that despite beliefs that technology could be helpful for people with traumatic brain injuries, health care professionals reported low levels of confidence in being able to assist their clients in using this technology, particularly if their own knowledge was limited. However, due to the increasing use of technology, particularly smartphones, it may be that professionals are now more confident in recommending such tools to their clients. This current study therefore used an online survey to investigate what technological and non-technological memory aids health care professionals recommend to their clients with dementia/MCI and what they believe the barriers to the use of technological memory aids are for this population.

Current study

This current study aimed to explore what technological and non-technological memory aids health care professionals working within Older People's Community Mental Health Services in Scotland are recommending/endorsing to people with MCI or Dementia. It also aimed to investigate what the barriers are to the use of technological memory aids for people with MCI or dementia, from the viewpoint of health care professionals working with this population.

In addition, a number of exploratory hypotheses relating to the frequency with which technological aids are recommended were also investigated:

H1: Non-technological approaches will be recommended more frequently than technological memory aids.

H2: Healthcare clinicians who rate themselves as more confident in using reminding technology will be more likely to recommend technology-based reminders to their clients.

H3: Clinicians who have been qualified for longer, and thus likely to be older in age, will be less likely to recommend technology-based reminders to their clients than clinicians who qualified more recently.

2. Methods

2.1 Design

This study utilised a single-phase cross-sectional study of health care professionals working in Older People's Community Mental Health Services in Scotland. Due to the Covid-19 restrictions, data were collected through an online survey.

2.2 Participants

A total of 138 health care professionals working within Older People's Community Mental Health Services in Scotland were recruited. The mean age (SD) of the participants was 44.3 (10.72) and ranged from 24 to 64 years. Details regarding the length of time working in Older People's services for the participants and their professional grouping can be found in tables 1 and 2 respectively.

2.3 Inclusion criteria

This study included health care professionals working with people with dementia and/or MCI as part of their role. All participants were aged 18 years and over and all gave informed consent to participation.

2.4 Procedure

The online survey was hosted on the onlinesurveys.ac.uk website. Participants were primarily recruited from the Older People's Community Mental Health Teams (OPCMHTs) in NHS Scotland with the survey being distributed through the respective team leads. The following NHS Scotland health boards were used for recruitment: Ayrshire & Arran, Borders, Dumfries & Galloway, Fife, Forth Valley, Grampian, Greater Glasgow & Clyde, Highland, Lanarkshire, Orkney and Tayside. NHS Western Isles and Lothian also agreed to recruitment but due to the timing of their approvals, no participants were recruited via these health boards.

The survey was also distributed via the British Psychological Society Division of Clinical Psychology Faculty of the Psychology of Older People's Scottish network and was advertised on a Private Facebook group for Clinical Psychologists working with Older People in the UK. The survey was also advertised via Twitter, through the Royal College of Nursing Scotland and the Royal College of Occupational Therapists Older People's section.

2.5 Measures

The online survey consisted of:

1) A demographic questionnaire (age, gender, job title, number of years working in Older People's Community Mental Health Services).
2) A memory aid use checklist adapted from Jamieson (2016), which was previously adapted from Evans et al. (2003), to be suitable for health care professional's working with people with dementia.
3) A questionnaire on barriers to assistive technology adapted from Jamieson (2016)
4) A questionnaire regarding the health care professional's own familiarity with and use of technological and non-technological memory aids and their beliefs about the utility and effectiveness of such memory aids for people with dementia or MCI.

Copies of the measures together in the participant survey can be found in appendix 2.3

2.6 Ethics

Ethical approval was granted from the University of Glasgow College of Medical, Veterinary and Life Science ethics committee on the 5th of January 2021 (appendix 2.4). Management approval was granted by NHS Greater Glasgow & Clyde (appendix 2.5) and each of the additional health boards.

All participants gave informed consent.

2.7 Data analysis

Justification of sample size

To determine the target sample size, information on the number of health care professionals working in the older adult CMHTs within two West of Scotland health boards, was obtained. The number of staff in 13/19 of the community mental health teams was available. The mean number across both boards was to be used to estimate the number of health care professionals in each team in Scotland. However, as the mean number of staff per team in one of the boards (which is the largest health board in Scotland) was considerably higher than those in the other, it was decided to use the mean of the smaller health board (14.6) as this was considered likely to be more representative of the size of the teams in the rest of Scotland. It was established that there are around 52 teams in Scotland and an estimate of 759 health care professionals in Scotland.

Using a sample size calculator (https://www.smartsurvey.co.uk/sample-size-calculator), with N=759, z (confidence interval) =95% and e (margin of error) =5%, a target sample size of 255 was obtained.

Statistical analysis

The data was analysed using SPSS (version 27).

Descriptive statistics were used to show which memory aids the health care professionals typically recommend and the barriers to using assistive technology that they identified for the adults they work with who have dementia/MCI.

As Likert scales use ordinal data, a Wilcoxon Signed Rank Test was used to explore whether there was a significant difference between the frequency of which non-technological and technological memory aids were recommended. A total memory aid recommendation score was obtained for each participant for both technological and non-technological reminders. A points system for each level of response was used (never = 0 points; very rarely=1 point, sometimes =2 points, often = 3 points) for each form of technology and a total score calculated. A Spearman's correlation was used to analyse the association between length of time working in Older People's service and how likely they were to recommend electronic memory aids to their clients (on a 5-point Likert-type scale from strongly disagree to strongly agree). A Spearman's correlation was also used to analyse the association between the health care professionals' rating of their confidence of using reminding technology themselves and how likely they are to recommend electronic memory aids to their clients.

An additional planned exploratory analysis was conducted to explore whether there was any difference between the three most prevalent professions (Clinical Psychology, Occupational Therapy and Nursing) and their confidence in recommending technology as a reminding tool to clients/beliefs and whether they consider technology may be an effective way for people with memory problems to be reminded about things using Kruskal-Wallis tests. A Spearman's correlation was also utilised to explore the relationship between the healthcare professionals' confidence in using technology and tendency to recommend technological reminding tools to clients with dementia/MCI.

3. Results

3.1 Demographics

Participants were healthcare professionals working in NHS Older People's Community Mental Health services in Scotland. The mean age (SD) of the participants was 44.3 (10.72) and ranged from 24 to 64 years. The length of time working in older people's services and the professional groups of the participants are presented in tables 3 and 4 respectively. One participant out of the 138 declined to enter any demographic details and one did not enter their age.

Table 3. Age of participants

	Age (years; n=136)			
	24-35	36-45	46-55	56-65
Number of participants	38	30	43	26

Table 4. Number of years working in Older People's services.

	Time working in Older Peoples services (years)						
	<1	1-5	6-10	11-15	16-20	21+	Did not specify
Number of participants	4	27	23	27	18	38	1

Table 5. Spread of occupational groups across the participants.

Occupational Group	**Number of participants (%)**
Care Manager	2 (1.5%)
Clinical Psychology	23 (17%)
Health Care Support Worker/Assistant	13 (8%)
Mental Health Practitioner	1 (0.7%)
Nursing	38 (26%)
Neuropsychology	1 (0.7%)
Occupational Therapy	42 (30%)
Physiotherapy	6 (4%)
Post diagnostic support/dementia link worker	3 (2%)

Psychiatry	5 (4%)
Speech and Language Therapist	2 (1.5%)
Team Manager	1 (0.7%)
Did not report	1 (0.7%)

3.2 Prevalence of memory aid recommendations

As Table 5 shows, use of a whiteboard/wall chart and a diary were the most frequently recommended non-technological reminder by the healthcare professionals. Table 6 indicates that the use of an alarm clock, a watch with a date/timer and mobile phone were the most recommended technological tools. In terms of memory strategies, Table 7 highlights leaving objects in the same place or somewhere their clients will find them were recommend more frequently than the other approaches. As Figure 2 displays, non-technological memory aids and strategies are recommended more than technological tools overall by healthcare professionals.

Table 6: Frequency with which non-technological memory aids are recommended by healthcare professionals in Scotland.

Non-technological reminders	**Number (%) of respondents who typically recommend the non-technological reminder to clients with dementia/MCI**			
	Often	Sometimes	Very rarely	Never
Asking others to remind your client in person	85 (62%)	44 (32.1%)	7 (5.1)	2 (1.5%)
A diary to help them remember things coming up in future (e.g., appointments or things to do)	110 (80.9%)	22 (16.2%)	4 (2.9%)	0
A diary/journal to help them remember what they have done	78 (56.5%)	37 (26.8%)	24 (17.4%)	1 (0.7%)
Whiteboard or wall chart	113 (82.5%)	14 (10.2%)	8 (5.8%)	2 (1.5%)
Making a list of things to do on a piece of paper (e.g., a things to do list or a shopping list)	88 (63.8%)	41 (29.7%)	9 (6.5%)	1 (0.7%)
Making notes of what they need to remember in a notebook.	78 (56.5%)	47 (34.1%)	10 (7.2%)	3 (2.2%)
Post-it notes	37 (26.8)	42 (30.4%)	42 (30.4%)	17 (12.3%)
Non-electronic Dosette Box medication reminder	79 (57.7%)	36 (26.3%)	11 (8%)	11 (8%)

Table 7: Frequency with which technological memory aids are recommended by healthcare professionals in Scotland.

Technological reminders	**Number (%) of respondents who typically recommend the technological reminder to clients with dementia /MCI**			
	Often	Sometimes	Very rarely	Never
Mobile phone	28 (20.3%)	75 (54.3%)	30 (21.7%)	7 (5.1%)
Laptop computer or tablet computer (e.g., iPad)	12 (8.7%)	66 (47.8%)	46 (33.3%)	15 (10.9%)
Desktop computer	4 (2.9%)	35 (25.4%)	62 (44.9%)	37 (26.8%)
Television (e.g., Setting up the television to record programmes in case they forget to watch a programme)	9 (6.7%)	44 (32.6%)	44 (32.6%)	39 (28.9%)
Using a digital camera to take pictures of everyday events to remind them of what they have done.	6 (4.3%)	22 (15.9%)	53 (38.4%)	59 (42.8%)
Pager	0	3 (2.2%)	19 (13.9%)	116 (84.7%)
Electronic personal organiser	2 (1.5%)	8 (5.8%)	35 (25.5%)	92 (67.2%)
Dictaphone/voice recorder	0	11 (8%)	41 (29.9%)	87 (62.5%)
Alarm clock/ timer to remind them to do something	62 (45.6%)	55 (40.4%)	12 (8.8%)	7 (5.1%)
An internet-based calendar to remind them (such as Google calendar)	9 (6.6%)	31 (22.8%)	40 (29.4%)	56 (41.2%)
Asking someone to send them a text message to remind them about something	15 (10.9%)	47 (34.3%)	46 (33.6%)	29 (21.2%)
A watch with a date/timer to remind them	33 (24.1%)	48 (35%)	28 (20.4%)	29 (21.2%)
A smart watch	2 (2.2%)	30 (21.9%)	44 (31.2%)	60 (43.8%)
Electronic Dosette box pill reminder	14 (10.2%)	47 (34.3%)	36 (26.3%)	41 (29.9%)

Table 8: Prevalence of memory strategies aids are recommended by healthcare professionals in Scotland.

Memory strategies	**Number (%) of respondents who typically recommend the technological reminder to clients with dementia/MCI**			
	Often	Sometimes	Very rarely	Never
Mental retracing of their steps - to find misplaced items (e.g., 'where did I last see the keys?'…)	45 (32.8%)	62 (45.3%)	19 (13.9%)	11 (8%)
Repetitive practice-repeating tasks until they become a habit.	69 (50.7%)	46 (33.8%)	14 (10.3%)	8 (5.9%)
Leaving objects in places they will notice them to remind clients to use them, or take objects with them.	104 (76.5%)	21 (15.4%)	9 (6.6%)	3 (2.2%)
Leaving objects in the same place so they know where to find them	117 (84.8%)	18 (13%)	1 (0.7%)	2 (1.4%)
Rhymes or phrases to remember important information (e.g., 'remember the 5th of November')	21 (15.6%)	35 (25.9%)	50 (37%)	30 (22.2%)
Changing passwords or PIN numbers to combinations they use regularly	11 (8%)	32 (23.2%)	41 (29.7%)	55 (39.9%)
Writing on their hand (or elsewhere)	7 (5.1%)	15 (10.9%)	30 (21.9%)	86 (62.8%)
Alphabetic searching-Considering if a name or object begins with the letter A, B , C.....etc.	12 (8.8%)	34 (24.8%)	36 (26.3%)	55 (40.1%)

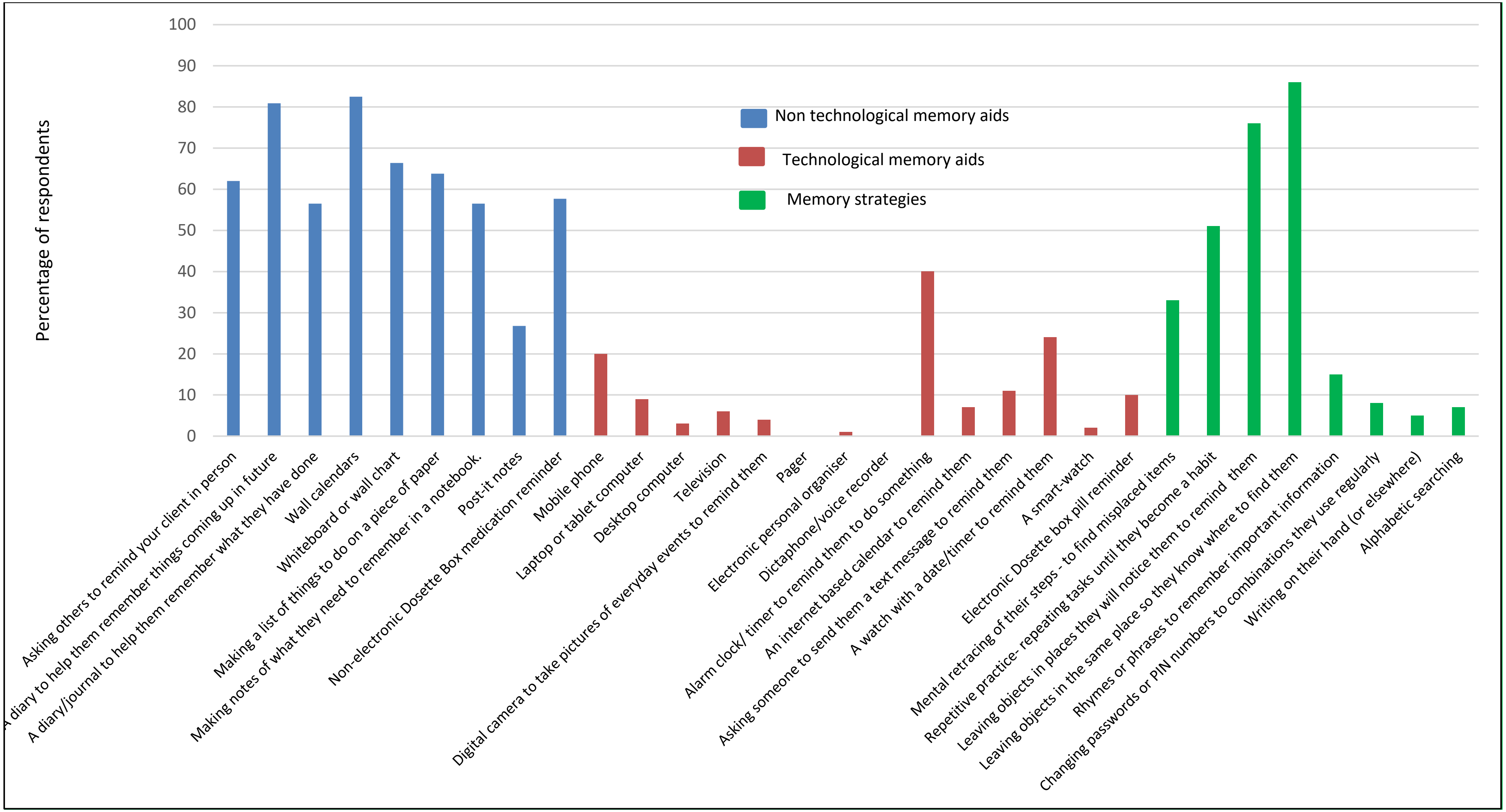

Figure 2: Frequency of memory aid/strategy recommendations made by healthcare professionals working with people with dementia/MCI

3.3 Healthcare Professional's confidence and familiarity in using technology and recommending technology to clients.

As Figure 3 shows, most of the healthcare professionals indicated that they use technology in their daily lives (98%) and feel confident in doing so (91%). In relation to recommending to clients, 71% of the healthcare professionals reported feeling confident in recommending to clients and the majority believe technology to be an effective way for their clients to be reminded about things (78%). Additionally, over 40% recommended technology as a reminding tool more during Covid-19 and 47% feel more confident in recommending technology to clients post Covid-19.

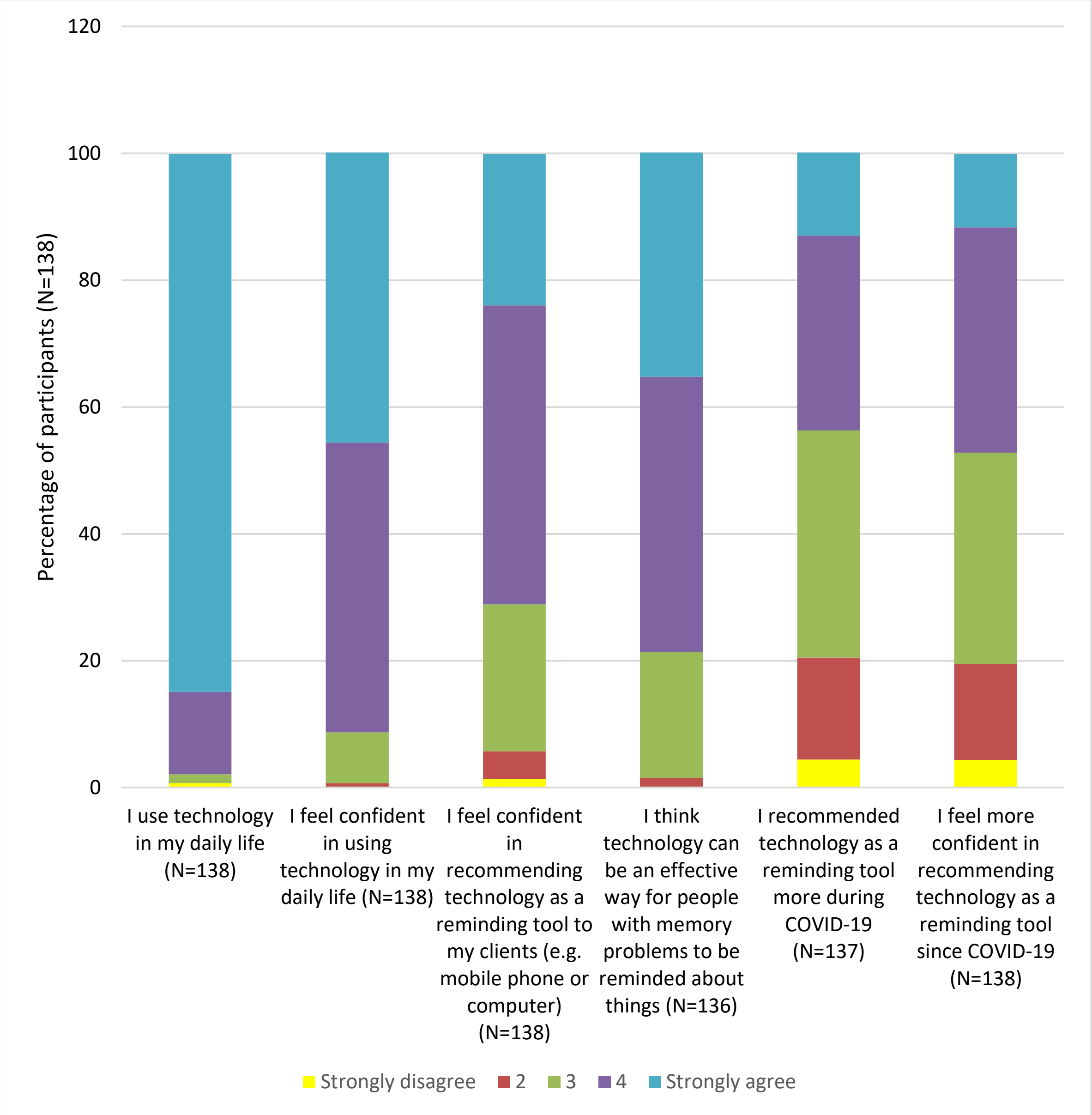

Figure 3: Healthcare professionals confidence and familiarity in using technology in their daily lives and confidence in recommending technology to clients as a reminding tool

3.4 Healthcare professional's beliefs regarding barriers to the use of technological memory aids for people with dementia/MCI

Figure 4 highlights which barriers the healthcare professionals believed to be most relevant for their clients. The most common barriers were that they believed their clients prefer writing things down than using a technological tool and that their clients would find it difficult to understand new technology. Very few of the healthcare professionals believed their clients would be able to learn how to use a new piece of technology.

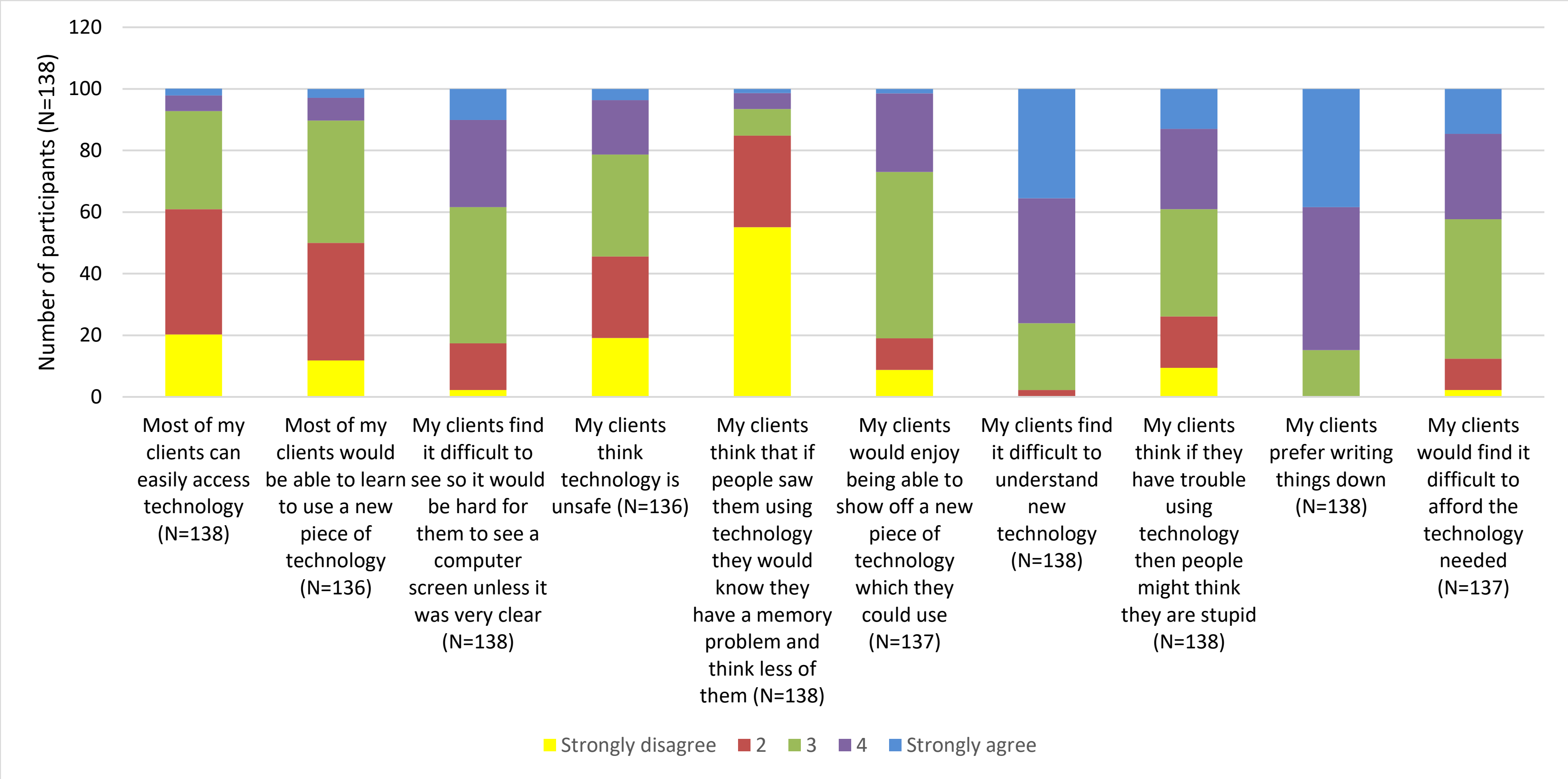

Figure 4: Healthcare professionals beliefs as to the barriers to the use of technological memory aids for people with dementia/M

3.5 Exploratory analyses

Comparison between frequency of non-technological and technological memory aid recommendations made by the healthcare professionals.

A Wilcoxon Signed Rank Test indicated that non-technological memory aids (mean rank=73.3) were recommended more than technological memory aids (mean rank=26.5) by the professionals, [$Z= -8.9$, $P<0.001$, $r=0.75$].

Relationship between length of time working in Older People's services and tendency to recommend technological reminding tools to clients with dementia/MCI.

A Spearman's rank correlation was computed to explore whether length of time healthcare professionals have worked in Older People's services was related to how often they recommend technology-based reminders to their clients. A significant positive correlation was found [$r(138) = .293$, $p<0.01$], indicating that as the length of time working in older peoples services increased, the healthcare professionals were more likely to recommend technological reminding tools.

Relationship between the healthcare professionals' confidence in using technology themselves and confidence in recommending technology to clients with dementia/MCI.

A Spearman's rank correlation coefficient was computed to determine the relationship between the healthcare professional's own confidence in using technology and confidence in recommending technology-based reminders to their clients with dementia/MCI. There was a significant positive correlation, [$r (138) = .422$, $p<0.01$] indicating that healthcare professionals who are more confident in using technology themselves were more confident in recommending technology-based reminders.

Relationship between the healthcare professionals' confidence in using technology and tendency to recommend technological reminding tools to clients with dementia/MCI.

A total technology recommendation score was obtained for each participant. A Spearman's rank correlation coefficient was then computed to determine the relationship between the healthcare professional's own confidence in using technology and their total technology reminding score. There was no significant correlation, [$r (138) =-0.063$, $p=0.461$]. This indicates that there was no relationship between the healthcare professional's confidence in using technology and whether they tend to recommend technological reminding tools to clients.

Confidence in recommending technology as a reminding tool to clients and beliefs as to whether technology can be an effective reminding tool for the main professions surveyed (Clinical Psychology, Occupational Therapy and Nursing).

The Kruskal-Wallis test found no significant difference between the confidence in recommending technology to clients with dementia/MCI between the healthcare professionals working in Clinical Psychology, Occupational Therapy and Nursing, [$H(2)=0.633$, $P=0.729$]. However, there was a significant difference between the three professions in their ratings as to whether technology can be an effective reminding tool for this population, [$H(2)=10.9$, $P<0.01$, $\eta^2= 0.06$]. Pairwise comparisons indicated that those working within Clinical Psychology ($M= 4.35$, $SD=0.57$) and Occupational Therapy ($M=4.25$, $SD=0.81$) were significantly more likely to believe technology can be an effective reminding tool for dementia/MCI than nursing professionals ($M= 3.74$, $SD= 0.79$).

4. Discussion

This study utilised an online survey to explore what memory aids healthcare professionals working in Scotland recommend to people with dementia/MCI and what they perceive the barriers to the use of technological aids to be. A wide range of professionals completed the survey with a range of experience, which is a key strength of the study. The most frequent professional groups were Occupational Therapists, Nurses and Clinical Psychologists.

Overall, the healthcare professionals were more likely to recommend non-technological aids than technological aids, as hypothesised. The most recommended technological reminder was the use of alarm clocks to help remember to do something. Mobile phones were also recommended, but only 20.3% of the healthcare professionals reported that they often recommend mobile phones. This is low in comparison to the most recommended non-technological memory aid which was recommended 'often' by 82.5% of the sample (wall chart/whiteboard). These results reflect those of Jamieson (2016) whereby people with dementia were more likely to perceive non-technological memory aids as more useful than technological aids. Likewise, the tools/strategies that participants in Jamieson (2016) rated as most helpful were leaving objects in regular places and wall calendars, which reflect the findings of the current study. Whilst the current study found mobile phones were recommended 'often' by 20.3% of the healthcare professionals, Jamieson (2016) found that under 5% of participants with dementia rated mobile phones as providing “a lot of help”. However, it is unclear whether the increase in widespread mobile phone use over the past six years may have influenced the healthcare professionals’ ratings in the current study or whether there is a mismatch between healthcare professionals’ views of the utility of mobile phones for reminding and the experience of people with dementia/MCI.

In terms of their own use of technology, the majority (98%) of the respondents use technology in their daily lives and feel confident in doing so (91%). Most of the healthcare professionals reported feeling confident in recommending technology as a reminding tool to their clients (71%) and believed technology can be an effective way for people with memory problems to be reminded about things (79%). However, this was lower than when rating their own use and confidence in using technology in their daily lives. Interestingly, over 40% of the healthcare professionals indicated that they recommended technology as a reminding tool more during Covid-19 and felt more confident in doing so. It is likely that the rapid implementation of remote appointments and meetings via video call platforms have contributed to these changes.

Interestingly, although most of the healthcare professionals believed technology could be useful as a reminding tool for their clients, most did not think their clients would be able to learn how to use new pieces of technology and believed clients would find new technology difficult to understand. This may suggest that some of the professionals held implicit biases and assumptions regarding older people’s ability to learn how to use technology and preference for non-technological approaches. Difficulties with vision and in affording technology were also indicated as barriers by some participants. However, only a small proportion (6.4%) felt client’s concerns over how others would perceive them for using technology to support their memory acted as a barrier to its use, suggesting the widespread use of technology in people’s daily lives, such as the use of smartphone calendars, has decreased the stigma of using such tools to aid memory allowing them to be more acceptable. Despite this, 39% of the healthcare professionals believed that a potential barrier for their clients would be concerns around other people thinking they are stupid if they find the use of technology difficult, highlighting a potential barrier for this group. The vast majority of healthcare professionals also believed their clients prefer to write things down rather than using technology and concerns around the safety of technology was perceived to be a barrier by 21% participants.

The findings of the exploratory analyses suggest that the healthcare professionals with more experience were more likely to recommend technology as a reminding tool to clients. This was contrary to the hypothesis that those who have been qualified for longer would be less likely to recommend technology-based reminders to their patients than healthcare professionals who qualified more recently. This may indicate that as the healthcare professionals' confidence develops through increased time in their role, they may have developed awareness of the ways in which technology can be used to support their clients' memory. Clinical Psychologists and Occupational Therapists were more likely to believe technology can be an effective reminding tool for dementia/MCI than nursing professionals, which is perhaps reflects core training in implementation of rehabilitation strategies. There was no relationship found between the professional's confidence rating in using technology and the likelihood that they would recommend technology-based reminders to their clients, thus providing no support for the hypothesis.

4.1 Future research and clinical implications

Although healthcare professionals recognise the potential effectiveness of using reminding technology for people with dementia/MCI, the majority believe that current technology is inaccessible or difficult to learn for their clients. This highlights the importance of further work in the design of specific technology, including smartphone apps, to ensure it is useable. Research on efficacy is also needed. Additionally, it is important to explore the best way for people with dementia/MCI to learn how to use new pieces of technology, such as through errorless learning, repetition and modelling. This topic has recently been explored in people with ABI in a study by Ramirez-Hernandez et al., (2021) which highlighted the importance of tailoring the intervention to the individual and the benefit of being supported by a trainer, in addition allowing more than one training session (Ramirez-Hernandez et al., 2021).

It is important that future research into the use of technological memory aids also involves service users living with dementia or MCI and thus the preferences and experiences of using technological memory aids should be explored. It may also be beneficial to investigate how healthcare professionals' beliefs of the barriers compare to actual difficulties experienced by people using the technology and using information from both to inform how to support cognitive rehabilitation using technology.

Although this study has gathered data regarding healthcare professionals' recommendations of memory aids made to clients, it would be useful to replicate Jamieson's (2016) study regarding frequency of memory aid use by people with dementia to update knowledge of current use.

Importantly, it will also be crucial to explore empirically whether technological reminding tools are more effective than the more commonly used non-technological tools and strategies.

The results of the current study highlights that healthcare professionals' confidence in using technology in their daily lives was related to their confidence in recommending technology-based reminders to their clients. This suggests that it may be helpful for professionals working with older people to receive basic training on the use of technology with the aim of increasing confidence around technology use. The findings also highlight that although most of the professionals believe technology can provide effective reminding tools for people with dementia/MCI, fewer reported feeling confident in recommending such tools to their clients. Therefore, additional training into how to actively promote the use of technological tools to improve the quality of life of people with dementia is important, as highlighted by the Technology Charter for People Living with Dementia in Scotland developed in partnership with multiple agencies including NHS Scotland and the Scottish Government (Alzheimer Scotland, 2015). Additionally, as the majority believed technological memory aids to be effective but also felt clients would be unable to learn how to use new technological tools, education in how best to support clients with memory problems to use new technology may also be helpful for healthcare professionals. It is also important that healthcare professionals are aware of the social and cultural factors which may affect a client's accessibility to the use of technological approaches, such as low income, ethnicity and disability. Digital exclusion also disproportionately affects older people with an estimated 79% of non-internet users being over the age of 65 (ONS, 2021).

It was recognised within the current study that the Covid-19 pandemic and associated enforced changes to service provision through remote approaches had encouraged many of the professionals to recommend technology as a reminding tool more than prior to the pandemic. It would be useful for future research to explore these changes further and to investigate whether these changes are maintained over time.

4.2 Study limitations

A limitation of the current study is that as the study utilised an online survey, participants may have been more likely to complete the survey if they already felt confident and interested in the use of technology which may have influenced their responses regarding their beliefs as to the effectiveness of technological memory aids and how often recommend them to clients. It may also have been helpful to have included use of voice assistants such as 'Alexa' and 'Google

Home' within the technological memory aid section of the survey, given the widespread use of such devices amongst the general population.. Additionally, due to delays caused by Covid-19, we failed to obtain approval from three health boards within the necessary timeframe, one of which is one of the largest boards in Scotland.

Although the current study provides an inclusive sample of healthcare professionals working with people with dementia/MCI in Scotland, it would have been preferable to have recruited from this large health board. Although the target sample size was not achieved, the range of different professions, ages, health boards and level of experience within the sample remains a strength of the study. However, the representativeness of the sample in comparison to the wider OPCMHT workforce is unknown.

4.3 Conclusions

This study indicates that healthcare professionals working with people with dementia or MCI recommend non-technological memory aids and strategies to their clients more frequently than technological reminding tools, with most frequently recommended memory aid being whiteboard/wall charts and leaving objects in the same place so they know where to find them. The most often recommended assistive technology was alarm clocks. Mobile phones were also recommended, but only 20.3% of healthcare professionals said that mobile phones are often recommended. These tools were recommended less than many other non-technological memory aids and strategies. This study also offers an insight into the beliefs of healthcare professionals from a range of professional backgrounds of the effectiveness of the use of technological reminding tools for people with dementia/MCI and what they perceive the barriers to the use of such technology to be. The main perceived barriers to the use of technological memory aids were that they believed their clients would find it difficult to learn how to use new technology and that their clients prefer writing things on paper. This indicates that although most healthcare professionals surveyed recognise technology as an effective tool for reminding, doubts remain as to how successfully this population can learn how to use and access such technology.

The current study has also highlighted potential training needs for healthcare professionals working with people with dementia and MCI and the need for specially designed technology which will be accessible and easy to learn for this population. Further research is also necessary to establish the effectiveness of technological reminding tools in comparison to other non-technological approaches.

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Appendices

Appendix 1.1 Submission Requirements for the journal Neuropsychological Rehabilitation

Preparing Your Paper

All authors submitting to medicine, biomedicine, health sciences, allied and public health journals should conform to the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, prepared by the International Committee of Medical Journal Editors (ICMJE).

Clinical trials: must conform to the Consort guidelines http://www.consort-statement.org. Submitted papers should include a checklist confirming that all of the Consort requirements have been met, together with the corresponding page number of the manuscript where the information is located. In addition, trials must be pre-registered on a site such as clinicaltrials.gov or equivalent, and the manuscript should include the reference number to the relevant pre-registration.

Systematic reviews: submitted papers should follow PRISMA http://www.prisma-statement.org/ guidelines and submission should also be accompanied by a completed PRISMA checklist, together with the corresponding page number of the manuscript where the information is located.

Single-case studies: submitted papers should follow SCRIBE guidelines (http://psycnet.apa.org/fulltext/2016-17384-001.html) and include a completed SCRIBE checklist together with the corresponding page number of the manuscript where the information is located.

Observational studies: submitted papers should follow the STROBE guidelines (https://www.strobe-statement.org/index.php?id=strobe-home) and also include a completed checklist of compliance, together with the corresponding page number of the manuscript where the information is located.

Qualitative studies: should follow the COREQ guidelines (http://www.equator-network.org/reporting-guidelines/coreq/) and be accompanied by a completed COREQ checklist of compliance, together with the corresponding page number of the manuscript where the information is located.

The EQUATOR Network (Enhancing the Quality and Transparency of Health Research) website provides further information on available guidelines.

Structure

Your paper should be compiled in the following order: title page; abstract; keywords; main text introduction, materials and methods, results, discussion; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figures; figure captions (as a list).

Word Limits

Please include a word count for your paper. There are no word limits for papers in this journal.

Format-Free Submission

Authors may submit their paper in any scholarly format or layout. Manuscripts may be supplied as single or multiple files. These can be Word, rich text format (rtf), open document format (odt), or PDF files. Figures and tables can be placed within the text or submitted as separate documents. Figures should be of sufficient resolution to enable refereeing.

- There are no strict formatting requirements, but all manuscripts must contain the essential elements needed to evaluate a manuscript: abstract, author affiliation, figures, tables, funder information, and references. Further details may be requested upon acceptance.
- References can be in any style or format, so long as a consistent scholarly citation format is applied. Author name(s), journal or book title, article or chapter title, year of publication, volume and issue (where appropriate) and page numbers are essential. All bibliographic entries must contain a corresponding in-text citation. The addition of DOI (Digital Object Identifier) numbers is recommended but not essential.
- The journal reference style will be applied to the paper post-acceptance by Taylor & Francis.
- Spelling can be US or UK English so long as usage is consistent.

Note that, regardless of the file format of the original submission, an editable version of the article must be supplied at the revision stage.

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Checklist: What to Include

1. **Author details.** Please ensure everyone meeting the International Committee of Medical Journal Editors (ICMJE) requirements for authorship is included as an author of your paper. All authors of a manuscript should include their full name and affiliation on the cover page of the manuscript. Where available, please also include ORCiDs and social media handles (Facebook, Twitter or LinkedIn). One author will need to be identified as the corresponding author, with their email address normally displayed in the article PDF (depending on the journal) and the online article. Authors' affiliations are the affiliations where the research was conducted. If any of the named co-authors moves affiliation during the peer-review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after your paper is accepted. Read more on authorship.
2. Should contain an unstructured abstract of 200 words.
3. You can opt to include a **video abstract** with your article. Find out how these can help your work reach a wider audience, and what to think about when filming.
4. Between 5 and 5 **keywords**. Read making your article more discoverable, including information on choosing a title and search engine optimization.

5. **Funding details.** Please supply all details required by your funding and grant-awarding bodies as follows:
For single agency grants
This work was supported by the [Funding Agency] under Grant [number xxxx].
For multiple agency grants
This work was supported by the [Funding Agency #1] under Grant [number xxxx]; [Funding Agency #2] under Grant [number xxxx]; and [Funding Agency #3] under Grant [number xxxx].
6. **Disclosure statement.** This is to acknowledge any financial interest or benefit that has arisen from the direct applications of your research. Further guidance on what is a conflict of interest and how to disclose it.
7. **Data availability statement.** If there is a data set associated with the paper, please provide information about where the data supporting the results or analyses presented in the paper can be found. Where applicable, this should include the hyperlink, DOI or other persistent identifier associated with the data set(s). Templates are also available to support authors.
8. **Data deposition.** If you choose to share or make the data underlying the study open, please deposit your data in a recognized data repository prior to or at the time of submission. You will be asked to provide the DOI, pre-reserved DOI, or other persistent identifier for the data set.
9. **Geolocation information.** Submitting a geolocation information section, as a separate paragraph before your acknowledgements, means we can index your paper's study area accurately in JournalMap's geographic literature database and make your article more discoverable to others. More information.
10. **Supplemental online material.** Supplemental material can be a video, dataset, fileset, sound file or anything which supports (and is pertinent to) your paper. We publish supplemental material online via Figshare. Find out more about supplemental material and how to submit it with your article.
11. **Figures.** Figures should be high quality (1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour, at the correct size). Figures should be supplied in one of our preferred file formats: EPS, PS, JPEG, TIFF, or Microsoft Word (DOC or DOCX) files are acceptable for figures that have been drawn in Word. For information relating to other file types, please consult our Submission of electronic artwork document.
12. **Tables.** Tables should present new information rather than duplicating what is in the text. Readers should be able to interpret the table without reference to the text. Please supply editable files.
13. **Equations.** If you are submitting your manuscript as a Word document, please ensure that equations are editable. More information about mathematical symbols and equations.
14. **Units.** Please use SI units (non-italicized).

Appendix 1.2 Search strategies by database

Source	**Search strategy**
APA PsycInfo (EBSCO host)	1.DE "Neurocognitive Disorders" OR DE "Consciousness Disorders" OR DE "Delirium" OR DE "Dementia" OR DE "Memory Disorders" OR DE "Mild Cognitive Impairment" 2. DE “Dementia” 3. DE “Alzheimer’s Disease” 4. DE “Vascular Dementia” 5. DE "Dementia with Lewy Bodies" 6. DE "Senile Dementia" 7. DE "Semantic Dementia" 8. DE "Presenile Dementia" 9. DE "Cognitive Impairment" 10. TX mild cognitive impairment" 11. TX "dement*" 12. TX "alzheimer*" 13. TX lewy W5 bod* 14. TX picks W2 disease 15. TX "parkinson* disease dementia" 16. TX "organic brain disease"

	17. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 18. TX "vanishing cue*" 19. TX "spaced retrieval" 20. TX "errorless skill learning" 21. TX "error-less learning" 22. TX "errorless learning 23. S18 OR S19 OR S20 OR S21 OR S22 24. S17 AND S23
CINAHL (Cumulative Index to Nursing & Allied Health)	1. MH "Dementia+" 2. MH "Alzheimer's Disease" 3. MH "Dementia, Vascular+" 4. MH "Lewy Body Disease" 5. MH "Dementia, Senile+" 6. MH "Frontotemporal Dementia+" 7. MH "Dementia, Presenile+" 8. MH "Mild Cognitive Impairment" 9. TX "dement*" 10. TX "alzheimer*" 11. TX "Lewy W5 bod*"

	12. TX "picks W2 disease" 13. TX "parkinson* disease dementia" 14. TX "organic brain disease" 15. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 16. TX "vanishing cue*" 17. TX "spaced retrieval" 18. TX "errorless skill learning" 19. TX "error-less learning" 20. TX "errorless learning" 21. S16 OR S17 OR S18 OR S19 OR S20 22. S15 AND S21

Appendix 1.3 Quality assessment ratings

		Criteria - Y; P; N; Not Applicable (NA)														
Authors	Year of publication	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Quality
Akhtar et al	**2006**	**Y**	**Y**	**P**	**P**	**N/A**	**N/A**	**N/A**	**Y**	**P**	**Y**	**N**	**Y/P**	**Y**	**Y**	**High**
Bier et al	**2008**	**Y**	**Y**	**Y**	**Y**	**NA**	**NA**	**NA**	**Y**	**P**	**Y**	**N**	**Y**	**Y**	**Y**	**High**
Bourgeois et al	2003	Y	P	Y	Y	NA	NA	NA	Y	P	P	N	Y	Y	Y	High
Bourgeois et al	**2016**	**Y**	**Y**	**Y**	**Y**	**P**	**Y**	**N/A**	**Y**	**Y/P**	**Y**	**N**	**Y**	**Y**	**Y**	**High**
Callahan	2019	Y	Y	Y	Y	P	N	N/A	Y	P	Y	Y	Y	Y	Y	High
Dechamps et al	**2011**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**N/A**	**Y**	**P**	**Y**	**Y**	**Y**	**Y**	**Y**	**High**
Dunn & Clare	2011	Y	Y	Y	Y	N/A	N/A	N/A	Y	P	Y	N	Y	Y	Y	High
Haslam et al	**2006**	**Y**	**P**	**Y**	**Y**	**N/A**	**N/A**	**N/A**	**Y**	**P**	**Y**	**N**	**Y**	**Y**	**Y**	**High**
Haslam et al	2011	Y	Y	Y	Y	N/A	N/A	N/A	Y	P	Y	Y	Y	Y	Y	High
Hochhalter et al	**2005**	**Y**	**N/Y**	**Y**	**Y**	**N/A**	**N/A**	**N/A**	**Y**	**P**	**Y**	**N**	**Y**	**Y**	**Y**	**High**
Jean et al	**2010**	**Y**	**Y**	**Y**	**Y**	**P**	**Y**	**N/A**	**Y**	**P**	**Y**	**N**	**Y**	**Y**	**Y**	**High**
Jokel & Anderson	**2012**	**Y**	**P/Y**	**Y**	**Y**	**N/A**	**N/A**	**N/A**	**Y**	**P**	**Y**	**Y**	**Y**	**Y**	**Y**	**High**
Kessels & Hensken	2009	Y	P	Y	Y	P	N	n/a	Y	P	Y	Y	Y	Y	Y	High
Lin et al	2010	Y	P	Y	Y	P	Y	N/A	Y	Y	Y	N	Y	Y	Y	High
Lubinsky et al	2009	Y	P	Y	Y	N/A	N/A	N/A	Y	P	Y	Y	Y	Y	Y	High
Metzler-Baddeley	**2005**	**Y**	**Y**	**Y**	**Y**	**N/A**	**Y**	**N/A**	**Y**	**N**	**Y**	**N**	**Y**	**Y**	**Y**	**High**
Mimura & Komatsu	**2010**	**Y**	**P/Y**	**P**	**Y**	**N/A**	**N**	**N/A**	**Y**	**P**	**Y**	**Y**	**Y/P**	**Y**	**Y**	**High**
Nonan et al	2012	Y	P	Y	P	N/A	N/A	N/A	Y	P	Y	Y	Y	Y	Y	High
Ozgis et al	**2009**	**Y**	**Y**	**Y**	**P**	**P**	**N**	**N/A**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**High**
Roberts et al	**2018**	**Y**	**Y**	**Y**	**Y**	**NA**	**NA**	**NA**	**Y**	**P**	**Y**	**N**	**Y**	**Y**	**Y**	**High**
Ruis & Kessels	2005	Y	Y	Y	Y	NA	NA	NA	Y	P	Y	Y	Y	Y	Y	High
Schmitz et al	2014	Y	Y	P	Y	n/a	n\a	n/a	Y	P	Y	Y	Y	Y	Y	High
Voigt-Radloff et al	**2017**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**NA**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**High**

Discrepancies between primary and secondary rater (primary/secondary)

NB papers which were second rated are highlighted in bold.

<u>Discrepancy discussion</u>

Akhtar et al (2006): *3. Method of subject selection (and comparison group selection, if applicable) or source of information/input variables (e.g., for decision analysis) is described and appropriate*- Decided on Partial as it is unclear where controls were recruited. 4. *Subject (and comparison group, if applicable) characteristics or input variables/information (e.g., for decision analyses) sufficiently described?* - Decided on Partial as gender not included. *12. Controlled for confounding?* - Decided on Yes as controlled for age and NART.

Bourgeois et al (2016): *9. Sample size appropriate?* - Decided on Partial as the number of participants in each group is small.

Hochhalter et al (2005): *2. Design evident and appropriate to answer study question?* - Decided on No as the design limits the EL nature of the experimental task.

Jokel & Anderson (2012*):* *2. Design evident and appropriate to answer study question?* - Decided on Partial as did not explicitly state design.

Mimura & Komatsu (2010): *2. Design evident and appropriate to answer study question?* - Decided on Partial as did not explicitly state design. *6. If interventional and blinding of investigators to intervention was possible, is it reported?* - Decided on N/A as it was within-subjects for the intervention. *12. Controlled for confounding?* - Decided on Yes as controlled for age and education.

Appendix 1.4 Scoring protocol for the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (Kmet, Lee & Cook, 2004)

The “total sum” is calculated by multiplying the number of “yes” by 2 and adding this to the number of “partials”. The “total possible sum” is then calculated by subtracting the number of “partials” multiplied by 2 from the total sum. The “summary score” is then calculated by dividing the total sum by the total possible sum, which derives a “summary score” between #zero and one. The authors (Kmet, Lee & Cook, 2004) did not suggest grading of the study quality and thus grading categories used in previous research was used (Buckman, Underwood, Clarke, Saunders, Hollon, Fearon & Pilling, 2018). The following score grading was used: A score of 0-0.25 was considered very low quality; 0.26-0.50 was considered low quality; 0.51-0.75 or studies which scored above 0.75 but scored 0 for sample size or not scoring 2 for the items concerning using appropriate outcome measures, conducting appropriate analyses, and supporting conclusions from the data, were considered moderate quality; studies which agreed with these criteria and also scored above 0.76 were considered high quality.

Appendix 1.5 Full data extraction table

Author(s), year, region	**Design**	**Aims**	**Sample (age, % male, diagnosis, cognition score i.e. MMSE)**	**Main outcome measure(s)**	**Details of the errorless learning intervention**	**Main findings**	**Quality rating**	**Limitations**
				Word list and other word learning tasks				
1.Akhtar et al, 2006, UK	Mixed design	Compare EL to EF for people with MCI. Explore if people with MCI are aware of the benefits of EL.	16 adults with MCI and 16 controls. <u>MCI group</u> Mean age= 78.19. Mean MMSE score= 27.31. <u>Control group</u> Mean age= 78.38.	Number of target words recalled (out of 10).	<u>Both conditions</u> Told they would be learning a list of words and would have to write them down. They were shown the words 3 times. <u>EL</u> Participants instructed, “I am thinking of a word	MCI group recalled fewer words than controls $F(1, 30)= 9.23$, $p = .05$ Both groups recalled more words in the EL condition $F(1, 30) = 34.12$, $p < .05$. More words recalled across trials $F(2, 60) = 61.21$, $p < .001$.	High	Did not report how controls were recruited. Did not specify gender. Small sample size. Estimates of variance or

			Mean MMSE score= 27.06. Gender not reported.		beginning with 'WA', and the word is 'WATER'". Asked to write the word down on a piece of paper which had the first 2 letters of the words. Paper then turned over so the word was covered. They were then asked how likely they would be able to remember the words from 0-100%. One 40-60 minute session.	Both groups more confident in their ability to remember the words in the EL condition over EF; MCI: F (1, 30) = 12.64, p< .01). Insufficient data to calculate effect sizes.		effect sizes not reported. Mean MMSE scores in the MCI group and control group were the same.

2. Callahan & Anderson, 2019, Canada	Mixed design	Compare EL and TEL under both lexical and conceptual conditions in people with MCI.	24 adults with MCI. <u>Conceptual condition</u> Mean age= 73.6. % male=42 No MMSE scores <u>Lexical condition</u> Mean age=74.2 % male=25 No MMSE scores.	Proportion of target words learned from a word list (out of 9).	<u>Lexical</u> Participants shown 9 words stems (e.g. SC_____), one at a time on a computer screen, followed by 1 of 5 nouns which match the stem (e.g. SCONE). <u>Conceptual group</u> Participants given 9 semantic cues e.g. a farm animal, followed by 1 of 5 nouns matching the cue e.g. chicken.	More words remembered in the EL phase compared TEL F (1, 11) =5.824, p=.025, effect size=0.209. No difference in proportion of words remembered in the conceptual group vs lexical F (1, 11) =0.023, p=.881. 24 hours later no difference between the EL and TEL conditions F (1, 11) =0.016, p=.901. Insufficient data to calculate effect sizes.	High	Method for randomisatio n not reported. Small sample size. No estimates of variance or effect sizes included.

					In the EL phase, the target word which matched the cue was presented straight away after the cue. An interference task was then given (counting backwards in 2's from 150). The 9 cues presented previously were then shown on the screen randomly and they had to write down the target words.			

3. Hochhalter et al, 2005, USA	Within-subjects design	Evaluate whether SR is more effective than expanding rehearsal, random rehearsal, uniform massed rehearsal or uniform distributed rehearsal.	10 adults with AD. Mean age= 83.6 % male==90 Mean MMSE score= 15.4	<u>Study 1</u> Number of participants able to recall name of a pill after a delay and the mean % error during training. <u>Study 2</u> Number of participants able to recall a non-verbal task.	Each participant practiced a different pill name with each learning condition. They were given a 'dime' for each correct answer. If they answered correctly, the next recall was at the next longer delay. If they answered incorrectly, the next recall was at the next shorter delay. The delays were at the following intervals: 0s, 10s, 30s, 1 min, 2 min, 4	<u>Study 1</u> No difference between the 5 conditions in long-term retention Q=5.2, p >.05. SR led to more errors during learning than expanding and random rehearsal. <u>Study 2</u> 3/4 participants could retain the non-verbal sequence, regardless of learning condition. No difference in number of errors made during training between the 5	High	Very small sample size. Did not report estimates of variance or effect sizes. In all conditions, including SR, they were asked to guess if they did not know the answer which limits the 'errorless' nature of the intervention.

					min, 7 min & 12 min.	conditions Xr^2= 5:4; $p > 0.05$.		
4. Lubinsky et al, 2009, Canada	Mixed design	Compare the effects of EL and EF learning, and experiment er-provided (EP) and self-generated (SG) learning, on recall, recognition and word-stem completion.	aMCI group 19 adults with aMCI Mean age= 76.9 % male= 53 Controls 19 healthy older adults. Mean age=73.7 % male= 47	Proportion of words correctly recalled during a word list learning task (12 max per each condition). Four conditions: EL-SG, EL-EP, EF-SG & EF-EP.	Word stems were provided in all 4 conditions. EL-SG The word stems were shown to the participants and they were given a cue. They were asked to give the target word but only if they knew it was correct. If they did not respond	Free recall Fewer errors in EL than EF in trials 1 & 2, $F (1, 36) = 7.03$, $p = .01$, $\eta2 = .17$, $F (1, 36) = 14.67$, $p < .001$, $\eta2 = .29$. Cued Recall Fewer errors in EL than EF $F (1, 36) = 87.29$, $p < .001$, $\eta2 = .70$ and SG was better than EP $F (1, 36) = 28.88$, $p < .001$, $\eta2 = .45$.	High	Design not clearly reported. Small sample size.

			No MMSE scores provided.		then a 2nd cue was given. If they still could not recall the target word, they were given the choice of 3 words (2 of which were nonwords, 1 was target word), which eliminated guessing. EL-EP Word stems shown to participants then immediately told the target word.	In EL conditions, cued recall resulted in fewer errors when SG than EP t (37) = 5.92, p < .001, η2 = .49. No such effect in the EF condition. Recognition Recognition better in EL than EF F (1, 36) = 16.07, p < .001, η2 = .31.		
5. Mimura & Komatsu, 2010, Tokyo	Within-subjects design.	Evaluate whether VC leads to better learning than EL	AD group 18 adults with AD.	Number of correct responses on a word-pairs task.	Each participant completed 4 sessions under the 4 conditions.	Free recall In the AD group, the EL conditions (VC&ELWF)	High	Did not explicitly state design.

		without fading (ELWF), category-generation or target selection, in people with AD or amnesic syndrome.	Mean age=77 % male= 50 Mean MMSE score= 22.4 <u>Amnesic syndrome group</u> 12 adults with amnesic syndrome. Mean age= 56.5 % male= 75 Mean MMSE score= 25.6		Each condition had 12 word-pairs of which the first word was a category and the 2nd an exemplar. After each training trial, there was a 3 min break and free recall was tested followed by cued. <u>VC</u> Exemplar word in its most degraded form (one letter and a word stem) shown together with	resulted in less errors than the EF, Wald X^2= 10.25, P < 0.001), but no difference between VC and EL. <u>Cued recall</u> In the AD group, EL (VC&ELWF) resulted in less errors than EF, Wald X^2 = 6.60, P < 0.01), but no difference between VC and EL. No significant benefit of effortful over effortless.		Unclear where participants were recruited. Small sample size. Did not report effect sizes.

					the category word. If they were unable to identify it, one less vanished step of the cue was revealed. This was repeated until they got the word correct. They were reminded not to guess. This condition was designed to be EL and effortful. <u>ELWF</u> A complete category-exemplar pair was	Insufficient data to calculate effect sizes.		

					shown. They were asked to say the word aloud and remember it.			
6. Roberts et al, 2018, Wales	Within-subjects design	Evaluate whether EL learning leads to better learning than EF learning in people with MCI-A.	19 adults with MCI-A. Mean age=76.8 % male= 42 Mean MMSE score= 26.74.	Number of words recalled on a word-list learning task (max. 12 words per condition).	Both the EL and EF learning lists consisted of 12 two-letter word stems with 4 potential endings for each word (e.g., cha______: chair, charm, chain, chapel). The words were shown on a computer screen and the participants were told to remember the words for	<u>Free recall</u> Participants remembered more words in the EL condition than EF $t(18) = 2.59$, $p = .019$, $\eta^2 = 0.3$. <u>Cued recall</u> Participants remembered more words in the EL condition than EF $t(18) = 3.45$, $p = .003$, $\eta^2 = 0.4$. In both EL and EF conditions, participants remembered	High	Small sample size. Did not report estimates of variance or effect sizes.

					a later memory test. <u>EL procedure</u> A word stem was shown on the screen for 1 second and the experimenter said "I am thinking of a word beginning with [word stem]", then presentation of the whole word for 3 sec whilst being told "And the word is [word], please write that down". After each list was shown, they completed a	significantly more words in the cued condition (t (18) = -5.85, p < .001, η2=0.7) than free recall (t (18) = -4.60, p = .000, < .001, η2= 0.6). <u>Recognition</u> No significant difference between EL and EF in recognising the target words t (18) = 1.79, p = .091, η2= 0.2. However, EL conditions resulted in more accurate identification of previously unseen words t (18) = 8.78, p < .000, η2= 0.8.		

					free and cued recall test. For free recall, they were asked to recall as many words from the list as possible. For cued recall, the word stems were shown and they were asked to complete each word-stem with one of the target words.			
Face-name associations								
7. Bier et al, 2008, Canada & Belgium	Mixed design	Explore if EL, SR and VC are efficient in increasing learning of face– name association s in early	15 adults with AD and 15 matched controls AD group	Proportion of errors produced on a face-name association task.	All learning conditions: Face-name association learning task (5 in total).	Learning AD group produced more errors than controls in all conditions (Mann-Whitney U test *ps*< .01).	High	Small sample size. No estimates of variance or effect sizes reported.

		AD and whether one approach is more efficient than others. Compare the three methods with TEL learning.	Mean age=73.3 % male= 40 Mean MMSE score=23.7 <u>Controls</u> Mean age=72.5 % male=40 Mean MMSE score= 29.2		<u>SR</u> Presented the face-name association and gave the following instructions "Here is a picture of a man, whose name is Mr X. Can you repeat this name and try to remember it?" The name was then hidden and the participant is asked to call it. Each time the recall intervals got longer (up to 5 minutes). If the participant made a mistake, the correct	AD group produced significantly more errors during TEL than with the 3 EL conditions during learning (Wilcoxon's Z = 23.41; p <.001). <u>Immediate recall</u> All learning conditions were efficient (free recall: Wilcoxon's Zs between 22.4 and 22.8, ps< .005; total score combining free and cued recall: Wilcoxon's Zs of 23.41, ps< .001; recognition: Wilcoxon's Zs between 22 and		

					answer was given and returned to the last correct recall interval. The five associations were learned in the same session with a new picture shown every minute. 30 minute session or when success criterion had been met for each picture (recall after 5 minute interval).	23.1; ps< .01). However, there was no difference between them. <u>Delayed recall</u> Delayed recall was poorer than immediate (Wilcoxon's Z, ps= .01). There were no differences between the conditions on combined free and cued recall or recognition (Wilcoxon's Z, ps>10). NB Insufficient data to calculate effect sizes.		

					EL Showed the picture and asked to repeat and remember the name. Both picture and name then hidden and then presented again immediately after and participant asked to recall the name. This was repeated for all of the associations. The participants had 20 seconds to answer and were given the name if			

					they could not recall it. Each name was repeated nine times in each session. <u>VC</u> 5 face-name associations presented for 5 seconds and the participants were asked to repeat the name and remember it. The picture was shown with the first five letters of the name which was progressivel y decreased over the trials. If they			

					got one wrong, a letter was added until they could recall the name. Task ended once 3 consecutive correct trials were achieved or after 30 minutes.			
8. Dunn & Clare, 2007, Wales	Within-subjects design	Explore whether people with AD can learn previously familiar and novel face-name associations.	10 adults with early-stage AD, vascular or mixed dementia Mean age=80.9	Number of face-name associations correctly named and number of errors.	<u>Paired associate (errorless and effortless condition):</u> Shown a face-name pair and told to say the name aloud and link it to	<u>Across all conditions</u> Participants were able to learn the face-name associations F (1, 9) = 64.579, p <.001. More famous faces were	High	Small sample size. Did not report estimates of variance or effect sizes. Mean MMSE for

		Explore whether VC and paired associates, which are ‘errorless’ and target selection or forward cueing, which are ‘errorful’ are most effective.	% male=50 Mean MMSE score=24.8		the face in the photo. <u>VC (errorless and effortful condition):</u> Each face was initially shown alongside the name and thereafter each time a letter was deleted until only the first letter of the first name was shown. They were asked to recall the target name but without guessing. If they could not recall the name, the previous	learned than novel faces, F (1, 9) = 7.408, p< .05. No significant interactions between learning intervention and type of recall (free or cued). <u>Comparison between conditions</u> No significant difference between the 4 learning conditions, F (3, 27) = 2.458, ns. <u>Effortful vs effortless</u> Only significant effect for novel faces within the		participants almost did not meet the cut off for a dementia (25/30).

					stage was shown to them again which was repeated until they got it correct. Each time the task got progressively harder with 1 less letter than they succeeded with in the previous trial or session. Participants were trained for 6 sessions (1 hour long) and were taught using all 4 learning conditions in each session.	cued recall condition whereby effortful was more effective than effortless $F(1, 19) = 2.567$, $p < .05$. No effect of reducing errors. Insufficient data to calculate effect sizes.			

9. Haslam et al, 2006, UK	Within-subjects design	Study 1 Understand the benefit of EL over EF learning across a range of knowledge levels. Study 2 Understand if familiarity-based judgments were possible within an EL learning model and if so, to evaluate the effectiveness of EL over EF learning.	Study 1 11 participants - 3 with probable AD and 8 controls. AD Mean age= 83.7 % male= 0 Controls Mean age =77.5 % male=12 Study 2 2 participants with probable AD.	Studies 1-3 Accuracy of face-name-occupation associations.	Study 1 EL task: For each face-name-occupation association, participants were advised the person's name started with a specific letter and were given the right answer immediately (e.g. "This person's name begins with the letter R and his name is Roger"). This procedure was repeated for the occupation. This was repeated for	Study 1 The "EL> EF" outcome occurred with greater frequency than EL≤EF $X^2(2) = 8.92$, $p<.05$. EL learning was more beneficial when low-level information was being retrieved. Study 2 Overall performance reduced between levels 1 and 3 at immediate and delayed recall. No significant difference in	High	Very small sample sizes. Design not clearly stated. Did not report estimates of variance or effect sizes.

		<u>Study 3</u> To ascertain whether this effectiveness of EL learning over EF holds for people with mixed dementia.	Mean age= 81 % male= 50 <u>Study 3</u> 7 participants with AD or VD Mean age=78.3 Gender not reported. No MMSE scores in any study.		the remaining 11 faces in the set and the entire process was repeated 3 times. A digit span was then given to distract the participant briefly before then asking 4 questions to access different levels of knowledge, from lowest to highest. The questions were as follows:	performance accuracy between EL and EF conditions at any knowledge level. <u>Study 3</u> Performance was better under EL conditions than EF F (1, 6) = 8.11; p< .05; r= 0.6. Participants performed significantly better at level 1 than level 2 t (1, 6) = 6.0, p< .01 and level 3 t (1, 6) =7.12, p< .001. The difference between		

					Level 1: "Is this person familiar?" Level 2: "Is this person a teacher or a musician?" Level 3: "Is this person a primary or high/seconda ry school teacher?" (For educators) or "Is this person a pianist or violinist?" (For musicians). Level 4: "What is this	performance in the EL condition compared to the EF condition only held at levels 2 and 3 $F(2, 12)=14.15$, $p< .001$ Insufficient data to calculate effect sizes.		

					person's name?" Two sessions of individual memory training with a 2 week interval between sessions. <u>Study 2</u> Same as study 1 but also introduced a two alternative forced-choice task to assess familiarity of the names by being asked to choose between the correct name and incorrect name, level 1B ""Is this			

					person's name ___ or ___?" <u>Study 3</u> Identical study procedure as study 1 but with 2 dementia types.			
10. Haslam et al, 2011, UK NB experiment 1 & 2 did not include adult with dementia/ MCI and so are not included.	Mixed design	Explore whether PWD show improved memory performanc e in SR conditions over that of EL and TEL.	<u>Experiment 3</u> 15 adults with dementia (AD, vascular or mixed) Mean age= 77 % male=33	Accuracy on a face-name association task during cued recall.	In all conditions (SR, EL &TEL), participants were told they would be learning 12 face-name associations shown on a computer screen. In each condition there were 4 trials and they were	Participants made no errors during naming in the EL condition and made more errors during TEL (M = 33.20, SD = 14.38) than SR M = 8.60, SD = 5.03); t (14) = 8.06, p < .001. Naming accuracy was better in the SR	High	Small sample size.

			Mean MMSE score=21.27		shown the correct association for 3 seconds. There was 8.5 mins between the learning trial and the test. For the dementia group in study 3, the recall was cued in that the face was shown with the first letter present and a word stem. <u>EL condition</u> During each trial, participants were shown the face	condition than TEL t (14) = 4.40, p = .001, effect size r = .76. No difference between SR and EL conditions t (14) = 1.60, p = .13. For cued recall, SR was better than EL conditions, t (14) = 2.42, p = .03, effect size r = .54.		

					alongside the correct name for 3s. After 8.5 mins (during which unrelated puzzles were used), they completed the recall test. <u>SR condition</u> Procedure was as per the EL protocol above. However, during the 8.5 min break, the unrelated puzzles were interrupted intermittently (30s, 1 min, 2 min & 5 min) where they were shown				

					the faces with again and asked to recall the names. They were told if correct and the correct name was presented.			
11. Jean et al, 2010, Canada	Between-subjects design	Evaluate the efficacy of EL combined with SR for people with MCI -A. .	22 adults with MCI-A. EL 11 participants Mean age=68.55 % male=36 Mean MMSE score=29.45 Control (EF) group	Number of names correctly recalled in a face-name association task. Novel (episodic) and famous (semantic) face-name associations (episodic).	20 face-name associations in total (5 famous and 5 novel per group). EL group At the start of the first session, 20 pictures of famous people from the 4 domains were shown briefly. The order was decided	No significant difference between the EL and EF groups. Both groups performance improved over time with both episodic ($F(2, 35) = 49.390$, $p<.001$) and semantic ($F(2, 35) = 11.569$, $p<.001$) material. Insufficient data to calculate effect sizes.	High	Did not describe method of randomisation Small sample size. Low power to detect significant results. Did not report estimates of variance or effect sizes.

			11 participants Mean age=68.55 % male= 25 Mean MMSE score=29.55		depending on the area the participants were most interested in to those of least interest. The participants were asked to give the first name, last name and occupation of the person in the photo. The EL paradigm involved 6 learning trials with five different intervals (30s, 1m, 2m, 5m & 10m) of SR. At the start of the session they			

					were shown the target pictures one at a time twice and they were told: "The name of this person begins by ___ and ___ (the experimenter says the first letter of the first and last names) and his (her) name is ______". Please write it down on this piece of paper". After writing it down, the participants were not allowed to see it during learning.			

					They were then asked "Can you tell me the first (or last) name of this person? If you are not sure of your response, please do not guess, just tell me that you don't know. I will then give you the correct answer." If they made an error during recall, the interval between trials was reduced to be equal that of the last successful trial.			

					If correct, the time interval was increased. At each session, the SR interval started with the longest successful interval in the prior session. Session finished when all 6 trials were complete or when 2 successive trials were correct at the 10 min delay. Six sessions which were twice a week over 6 weeks.			

12. Metzler-Baddeley & Snowdon, 2005, UK	Within-subjects design	Examine whether EL is a more successful training strategy than EF for people with AD.	4 adults with AD. Mean age= 68.5 Mean MMSE score= 19.8 % male= 75	Number correctly recalled names of both novel (face-name associations) and familiar (object naming) materials.	Participants learned all 4 sets consecutivel y. This was repeated 3 times a day (random order) for 8 days. <u>EL training</u> Participants were shown the picture of the object or face and were asked to unfold a card with the correct name of the object/face. They were told to write the name and were encouraged to make use of	For free recall of both novel and familiar material, participants recalled more in EL compared to EF $t(3) = 2.5$, $p < 0.05$, $\eta2=0.7$. For familiar material and novel material separately, participants recalled more in EL than EF $t(3) = 2.6$, $p < 0.05$ (novel), $\eta2=0.7$, $t(3) = 2.5$, $p < 0.05$ (familiar), $\eta2=0.7$.	High	Extremely small sample size. Did not report estimates of variance or effect sizes.

					mnemonics that might help them remember the name. The participants were told not to guess or to ‘test’ themselves during the session but to instead look carefully at the name of the object/face. After the training session of each condition, free recall was tested. If they were unable, cues			

					were provided.			
13. Ruis & Kessels, 2005, The Netherlands	Within-subjects design	Evaluate the effectiveness of EL in participants with moderate-severe dementia, on a face-name association task.	10 adults with probable AD. Mean age= 81.8 % male= 50 Mean MMSE score= 16	Number of correct face-name associations.	<u>EL condition</u> Participants asked to learn 10 face-name associations. They completed 2 learning trials. The experimenter gave the correct name straight away. Delayed recall test 10 minutes later. There was 1 week between the EL and EF learning sessions which were counterbalan	Significantly more correct face-name associations in the EL learning condition than EF but only in trial 2 t(9)=3.50, p=0.007). No significant difference for delayed recall. Insufficient data to calculate effect sizes.	High	Small sample size. Did not report effect sizes.

					ce across the groups.			
Picture naming								
14. Jokel & Anderson, 2012, Canada	Within-subjects design	Explore whether EL leads to greater learning improvements than EF and active learning over passive.	7 participants with semantic dementia. Mean age=68.2 % male= 43 No MMSE scores.	Proportion correct on a picture naming task from the Peabody Pictures set.	<u>Errorless-passive condition</u> Each picture was shown to the participant and cues and names were provided when needed e.g. if shown a picture of an apple the experimenter would say “This is an apple. It is a round and red fruit. It is sweet and juicy. It grows on trees. It begins with the letter ‘A’. It has	<u>Naming test</u> EL was more effective for name learning than EF F (1, 6) = 25.31, P<.002, effect size= .81. This increased over the sessions F (11, 66) =5.08, p< .006, effect size= .46. <u>Recognition</u> There was no significant benefit of EL (F (1, 5) = 2.192, p< .20) over EF or active over passive learning (F (1, 5) =0.625, p <.47.	High	Did not explicitly state design. Very small sample size.

					two syllables. Apple. Please repeat”. <u>Errorless-active condition</u> Each picture was shown to the participant and cues and names were provided when needed e.g. if shown a picture of a tomato the experimenter would say “Is this a fruit? Is it round? Is it red? Is it juicy? Does it begin with the letter ‘T’? Does it have three syllables? Is	There was also no interaction. At 1 month f/u, the maintenance of naming was larger after EL than EF F (1, 6) = 16.98, p< .006, effect size= .74.		

					it a tomato? Tomato. Please repeat". The experimenter would wait for an answer after each question and the answer was always "yes" so as to be more challenging than the passive condition but not confusing. Naming accuracy was tested after each session. Semantic knowledge of target items was tested after each list.			

					Maintenance of naming effects was f/u at 1- and 3-months post-treatment. 8 sets of 15 pictures each (4 with no semantic items and 4 with semantic items) were treated. Each set was given over 12 sessions with two 30 min sessions per day (96 sessions).			
15. Noonan et al, 2012, UK	Within-subjects design	Evaluate whether EL and EF is equally effective when relearning the names	8 adults with AD and severe anomia.	Proportion of items correctly recalled from a picture of the item.	<u>EL therapy</u> Picture presented with the target word to name the picture	At 1 week post-therapy, both EL and EF therapies improved item naming more than no treatment t (7)	High	Design not clearly stated. Did not give age/gender. demographics.

		of previously known and well-used everyday items and animals.	Mean MMSE score= 17.9 No age or gender details provided.		(spoken and written), which was repeated 3 times before moving to the next picture. Each item was shown 3 times/session in both EL and EF conditions. There were 10 40–60-minute sessions.	=5.1, two-tailed p>.001; t (7) =5.3, p<.001. However, there was no difference between EL and EF or at week 5 post-therapy. For the EL condition, naming improved at week 1 and 5, compared to baseline t (7) = 6.3, p <001; t (7) = 4.0, p=.005. However, performance was slightly poorer at week 5 than week 1 t (7) =3.2, p <.014. Similarly, for the EF condition, naming significantly		Small sample size. Did not report effect sizes.

						improved at week 1 and 5, compared to baseline t (7) = 5.4, p< .001; t (7) = 4.8, p<.002. However, there was no decline in performance between the time points in the EF condition. Insufficient data to calculate effect sizes.		
ADL tasks								
16. Bourgeois et al, 2003, USA	Within-subjects design	Compare efficacy of SR and a modified Cued Hierarchy (CH) for teaching PWD to use an external memory	25 adults with dementia (mixed sample of organic, AD, senile and not specified).	Goal outcomes in relation to ADLs.	SR Clinician says to participant "I understand that sometimes you have trouble remembering what	Participants were more successful in achieving their goals when using SR compared to CH, F (1, 24) = 4.99, P < 0.035. No difference in the number of	High	Design not clearly reported. Small sample size. No estimates of variance or effect sizes reported.

		aid for a particular purpose.	Mean age=83.6 % male= 36 Mean MMSE score= 15		activities there are to do here. If you want to know what activity you should do today, you can look at this list of activities. What can you do to know what activity you should do?'' The anticipated response would be ''I look at my activity list.'' If the right response was given straight away, the clinician replied, ''That's right. And	trials and sessions it required to master a goal between the two conditions. More goals maintained in SR group compared to CH group at 1-week follow-up (Z=-2.33, P < 0.02) and 4 months (Z= 0.20, P < 0.05). NB Insufficient data to calculate effect sizes.		

					I’ll be asking you to remember that in a little while,’’ and then talks about another topic for the specified interval (i.e., 30 s, 1 and 2 min, etc.). If the correct response keeps being given immediately, the clinician prompted the participant at increasingly longer intervals over 30 minutes. If the participant did not respond/resp onded			

					incorrectly, the clinician modelled the right response, and the subsequent prompt was given at the last interval that elicited a correct response. The goal was mastered when the right response was given to the 1st prompt of the next 3 sessions, with a min. of 24 hours between them. NB the instructions differed depending on what goal			

					was relevant to each participant.			
17. Bourgeois et al 2016, France.	Between-subjects design	Evaluate the effectiveness of TEL, EL and Modelling with SR (MR) on the relearning of ADLs in participants with mild to moderate AD.	52 adults with mild-moderate AD. <u>EL</u> 16 participants Mean age= 83.7 Mean MMSE score= 15.9 <u>MR</u> 16 participants Mean age= 86.8 Mean MMSE score= 17.9 <u>TEL</u>	ADL task performance	<u>EL intervention</u> The therapist gave the participant the different steps required to complete the ADL giving instructions and visual (pictorial or written) cues. Cue cards then hidden, and the participant was asked to immediately give the answer about the steps needed to complete the ADL. If not given within	Participants' performance improved across all groups across all learning sessions $F(1, 49) = 97.64$, $p<0.001$. No significant difference between the 3 learning conditions $F(2, 49) = .93$, $p=.4$. Improved performance maintained at 1 month follow-up $F(1, 49) = 2.92$, $p=.09$. No difference in performance between the 3 learning conditions at 1	High	Method of randomisation not reported. Small sample size. No estimates of variance or effect sizes included.

			21 participants Mean age= 83.8 Mean MMSE score= 18.1 Gender not reported.		5 seconds, the therapist gives a cue (verbal/visual or physical help) and moves onto the next step. <u>MR intervention</u> The therapist performs each step whilst using verbal cues and asks the participant to do it after them. 30 seconds was given between the demonstration and the participant completing the steps. After each 30 seconds	month follow up F (2, 49) =1.43, p=.25. NB Insufficient data to calculate effect sizes.		

					the therapist adds on another step and remodels the entire sequence. If an error is made the therapist remodels the correct action and repeats the entire sequence. If the participant makes the error at a step which was been previously rehearsed successfully, the therapist gives a cue for the wrong step and asks them to continue. If they cannot,			

					the therapist remodels the correct steps and returns to the last successful step and repeats the sequence again.			
18. Dechamps et al, 2011, The Netherlands	Within-subjects design	Observe whether EL, learning by modelling (LM) or TEL improve most the (re)learning of skills related to ADL in different dementia severities.	14 adults with AD. Mean age=86 % male=14 Mean MMSE score=15	Implicit learning: the ability to carry out the specific ADL task Explicit learning: Cue card sorting	<u>EL</u> Participants were given formal information about the task they are learning e.g. ‘‘Here is an electric kettle and some tea bags, I will ask you to make a cup of tea”. They were then given cues before completing a	The EL and LM learning conditions improved implicit (procedural) performance when carrying out the ADL most over the 6 sessions. For the LM condition, the baseline to 1 week f/u showed a 33.0% improvement, CI95% [6.1-60], P=.01 and 30.8%, CI95% [5.8-55.9], P=	High	Small sample size

					sequence ‘‘you can take a mug (or a cup)’’. This was done for each step in the procedural sequence. They were asked to wait until the instruction had been given to avoid errors. Each session lasted 45 minutes (30 minutes of training) for 6 sessions over 7 days.	.009 for the baseline to 3-week f/u. There was significant progression over time (F(7,91)=8.7, P < .001, ηp2 = 0.42 For the EL condition, the baseline to 1 week f/u showed a 22.2.0% improvement, CI95% [6.6-37.8], P=.01 and 24.2%, CI95% [7.7-40.8], P= .002 for the baseline to 3-week f/u. There was significant progression over time (F (7, 91) =7.0, P < .001, ηp2= 0.35.		

						For the TEL condition, the baseline to 1 week f/u showed a 12.2%, CI95% [1.7-22.7], P=.015 and 6.8% (CI95% [-8-21.5]) at the 3-week f/u. There was significant progression over time (F (7, 91) =5.8, P < .001, ηp2 = 0.3. The LM and EL conditions were more effective for the implicit learning task (procedural) compared to TEL, with a mean difference of 15.2% CI95% [6-24.4], P= .002 (LM) and 9.6% CI95% [-1.2-		

						20.3], P=.09 (EL). No differences between the 3 learning conditions for the explicit learning tasks (ordering of instruction cards).		
19. Lin et al, 2010, Taiwan	Between-subjects design	Evaluate the effectiveness of SR vs Montessori-based activities for eating difficulty in adults with dementia.	<u>SR group</u> 32 adults with dementia. Mean age= 79.69 % male= 43.8 Mean MMSE score= 13.56 <u>Montessori group</u>	Edinburgh Feeding Evaluation in Dementia (EdFED) and assisted feeding scores.	<u>SR group</u> 8 weeks of training which focused on eating procedure and eating behaviour over increasing time intervals.	Both SR and Montessori-based had significantly lower EdFED scores (reduced feeding difficulties) than controls ($P<0.05$) and required less feeding by carers ($P<0.05$; $P<0.01$). The SR group had better nutritional status at 8 weeks than	High	Design not clearly reported. Did not fully describe randomisation procedures. The description of the study procedures was limited. Did not compare the two interventions, compared

			29 adults with dementia. Mean age= 82.9 % male= 58.6 Mean MMSE score= 10.83 <u>Control group</u> 24 adults with dementia. Mean age= 82.9 % male= 58.6 Mean MMSE score= 10.83			controls (P<0.01). However, the Montessori group had poorer nutritional status at 8 weeks than controls (P<0.01). Insufficient data to calculate effect sizes.		each to controls only. Did not report estimates of variance or effect sizes.

20. Voigt-Radloff et al, 2017, Netherlands	Between-subjects design.	RCT comparing EL to TEL on the carrying out of ADLs in people with mild-moderate dementia who live at home.	EL group 69 adults with mild-moderate dementia. Mean age= 76.7 %male= 42 Mean MMSE score= 19.8 TEL group 81 adults with mild-moderate dementia. Mean age =76.2 %male= 44 Mean MMSE score= 19.7	ADL task performance as assessed by the Core Elements Method (CEM).	EL condition Each participant trained in 2 tasks (task A & task B). The therapist split the task into steps, showed and described the 1st step. The participant was then asked to perform this step whilst the therapist gave verbal instruction. The therapist immediately showed the right performance if they anticipated a prospective error. When the first step had been	Both EL and EF groups showed better task performance from baseline to week 16: standardised effect size (95% CI): task A, 0.61 (0.37–0.85); task B, 0.47 (0.23–0.71)) and to week 26 (task A, 0.41 (0.17–0.64); task B, 0.26 (0.03–0.50)). There was no time by group interaction.	High	None identified.

					performed correctly, the next step was then shown. This continued for 30 minutes or until the whole task had been performed. After session number 5, the therapist was able to reduce the amount of demonstration and instruction given but was permitted to increase this if errors were made or they seemed unsure. They were given 9			

					sessions (weeks 3-10) and two refresher sessions at week 19-20.			
Cognitive tasks								
21. Kessels & Hensken (2009), The Netherlands	Mixed design	Compare EL to EF in adults with mild-moderate/severe dementia, and controls	Mild-moderate dementia group 20 adults. Mean age (EL condition)= 76.5 % male=30 Mean MMSE score= 22 Mean age (EF condition) =77.1 % male=40	Number of steps completed without assistance during a problem-solving task from the Dysexecutive Syndrome (BADS) battery.	Cues given prior to the participant before the step in the sequence e (e.g., "you can use the hook to remove the lid").	Immediate Participants with mild-moderate dementia performed worse than controls (p = 0.022) and those with severe dementia performed worse than the mild-mod group (p = 0.001). EL was more effective than EF, F[1,54] = 6.8, p = 0.012 Moderate effects of EL	High	Design not clearly reported. Small sample size. Did not report randomisation procedure. Investigator not blind to condition.

			Mean MMSE score=21 <u>Severe dementia</u> 20 adults Mean age (EL condition)= 83.6 % male=40 Mean MMSE score= 10.3 Mean age (EF condition) =83.2 % male=10 Mean MMSE score=10.3			were found in the mild-moderate dementia group a (d = 0.52) and severe dementia (d = 0.31). <u>Delayed</u> Large effects of EL were found in the mild-moderate dementia group (d = 1.61) and severe dementia (d = 1.0).		

			Control 20 adults Mean age (EL condition) = 72.7 % male=70 Mean MMSE score= 27.7 Mean age (EF condition) =71.9 % male=50 Mean MMSE score=27.5					
22. Ozgis et al, 2009, Australia	Mixed design	Explore effectiveness of SR for improving PM function in	Experimental group 30 adults with MCI.	Correct responses made on a PM measure using a Virtual Week boardgame.	Both conditions Participants were provided the instructions for the game	For MCI, SR significantly improved their performance on the PM boardgame task	High	Minimal demographics reported. Did not report randomisatio

		adults with MCI.	Mean MMSE score= 24.6 % male= 40 <u>Control group</u> 40 healthy older adults. Mean MMSE score= 28.7 % male= 17 The ages of participant were not reported. However, there was no significant difference between		and were told to complete one day as a practice trial. They practiced the regular tasks, and the irregular tasks were practiced at the end of the practice day. Following the practice day, participants in in the standard rehearsal group rehearsed the PM task by recalling it correctly out loud 3 times for each PM task.	F (1, 66) = 19.67, p <0.001. No difference between the control and MCI group's performance during the SR condition. During the standard rehearsal condition, the MCI group were poorer than controls d = 0.32.		n or blinding process.

			the two groups t (68) = 1.55, p = 0.125.		However, for the SR condition, they did this at increasingly longer intervals (5-, 10-, 20-, 40- and 60 intervals) and only went to the next interval when they correctly recalled all tasks.			
23. Schmitz et al, 2014, Canada	Mixed design	Compare effectiveness of EL and EF learning in a perceptual-motor task in people with AD.	Experimental group 14 adults with early AD. Mean age= 79.4 % male= 50	Learning task Number of errors made during a perceptual-motor learning task.	4 white squares presented horizontally on a black background. Four coloured keys on an AZERTY keyboard (C–V–B–N)	Learning task Participants in both groups were quicker in the second learning task than the first $F(1, 24) = 0.78$, $p = 0.39$, $\eta p2 = 0.03$.	High	Small sample size. Did not report where participants were recruited from.

			Control group 14 healthy older adults. Mean age= 78.8 % male= 40 No MMSE scores.	Serial Reaction Time (SRT) task Median reaction time (RT) and number of errors.	which corresponded to the positon of the squares were used. In both the EL and EF conditions, there was a random block, 4 explicit training blocks and a SRT task (3 blocks). Lastly, a generation task was used to assess explicit knowledge of the sequence. In the training phase, a blue star was shown in the	AD group produced more errors than controls $F(1, 24) = 24.45$, $p < 0.001$, $\eta p2= 0.51$ Significantly less errors were made in the EL condition than EF in both groups $F (1, 26) = 274.60$, $p < 0.001$, $\eta p2= 0.91$. SRT task In the AD group, for the EL condition RTs were longer in the transfer blocks compared to the sequence blocks ($p = 0.005$) showing a learning effect.		

					4 locations on the screen and the participant had to react as quickly as possible by pressing the key that corresponde d to the location of the star on the screen. This training block comprised 60 trials to allow them to get used to the task. <u>EL learning condition- leaning task</u> Participants asked to learn a sequence. For EL learning, the	Effect not present for EF condition.		

					target appeared on the screen in the correct location before they responded so that they could then press the correspondin g key in the sequence resulting in marginal errors. <u>SRT task (procedural knowledge task)</u> Participants had to react as fast as possible to the appearance of the target on the screen by pressing the key that corresponde			

					d with the location of the target. <u>Generation task (explicit knowledge task)</u> First of all participants told to attempt to produce the learned sequence. They were then asked to generate a new sequence that differed as much as possible from the learned sequence. There were 20 trials, and they were told to not to press the same key			

					twice successively.			

Appendix 1.6 Additional data table indicating significant results

Author	Type of learning	Errors during learning calculated	Length of recall	Type of recall
Word learning				
1.Akhtar et al, 2006	EL	No	Immediate*	Free*
2. Callahan & Anderson, 2019	EL	No	Immediate*& delayed (24 hours)	Cued*
3. Hochhalter et al, 2005	SR	Yes	Delayed (1 day-1 week)	cued
4. Lubinsky et al, 2009	EL	No	Immediate*& delayed (20 mins) *	Free*, cued* & recognition*
5. Mimura & Komatsu, 2010	VC & EL	No	Immediate*	Free* & cued*
6. Roberts et al, 2018	EL	No	Immediate*	Free*, cued* & recognition
Face-name associations				
7. Bier et al, 2008	EL, SR & VC	Yes*	Immediate & delayed (2 weeks)	Free, cued &recognition
8. Dunn & Clare, 2007	VC & paired associates	No	Immediate & delayed (half a week)	Free, cued & recognition.

9. Haslam et al, 2006	EL	No	Immediate* & delayed (30 mins)*	Free
10. Haslam et al, 2011	SR & EL	No	Immediate*	Free* and cued*
11. Jean et al, 2010	SR+EL	yes	Immediate & delayed (10 mins)	Free & cued
12. Metzler-Baddeley & Snowdon, 2005	EL	No	Immediate*	Free & cued combined*
13. Ruis & Kessels, 2005	EL	No	Immediate* & delayed (10 mins)	Free*
Picture naming				
14. Jokel & Anderson, 2012	EL	Yes*	Delayed (1 & 3 months) *	Recognition
15. Noonan et al, 2002	EL	No	Delayed (1 & 5 weeks)	Free
ADL tasks				
16. Bourgeois et al, 2003	SR	No	Immediate* & delayed (one week & 4 months) *	Free*
17. Bourgeois et al 2016	EL & SR	Y	Immediate & delayed (1 month)	Free
18. Dechamps et al, 2011	EL	No	Immediate* & delayed (1 & 3 weeks)*	Free only*

19. Lin et al, 2010	SR	No	Delayed (8 weeks) *	Free*
20. Voigt-Radloff et al, 2017	EL	No	Delayed (16 & 26 weeks)	Free
Cognitive tasks				
21. Kessels & Hensken (2009)	EL	No	Immediate* & delayed (1-3 days) *	Free
22. Ozgis et al, 2009	SR	No	Immediate*	Free*
23. Schmitz et al, 2014	EL	Yes*	Immediate*	Free*
*Denotes that EL performed significantly better than comparator				

Appendix 2.1 Participant information sheet

Version 4 11/12/2020

A survey of memory aid recommendations made by health professionals working with people with dementia and mild cognitive impairment in Scotland

Participant Information Sheet

I would like to invite you to take part in a research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. If there is anything that is not clear or if you would like more information then please contact me using the contact details below.

Who is conducting the research?

The research is being carried out by Katie Ferry (Trainee Clinical Psychologist) and Professor Jonathan Evans (Professor of Applied Neuropsychology) from the Institute of Health & Wellbeing at the University of Glasgow, and Dr Sally McVicar from the Young Onset Dementia Service, NHS Greater Glasgow & Clyde.

What is the purpose of the study?

Memory impairment affects most people with a diagnosis of dementia, causing difficulties remembering things that have already happened (retrospective memory), as well as remembering to do things in the future (prospective memory). Memory aids can be used to help people remember to do things, which can improve quality of life and independence. Memory aids include things like diaries, calendars, wall-charts as well as electronic aids such as mobile phones. Electronic memory aids have been shown to be effective in supporting remembering in people with brain injuries; however, they are used less often by people with dementia. This study aims to explore what technological and non-technological memory aids clinicians working within Older People's services in Scotland currently recommend to people with Mild Cognitive Impairment or Dementia. It also aims to investigate what the barriers are to the use of technological memory aids for people with Mild Cognitive Impairment (memory problems) or dementia, from the viewpoint of clinicians working with this population in Scotland.

This study is recruiting participants from all health boards in Scotland and aims to recruit 255 participants.

Why have I been invited?

You have been invited to take part in this study because you are a health care professional working in Scotland with people with dementia and/or Mild Cognitive Impairment as part of your role.

Do I have to take part?

No. It is entirely up to you to decide if you would like to take part. You will be asked to complete a consent form to show you have agreed to take part. However, you are free to withdraw up to the point of anonymisation without giving reason. Once the survey is completed and submitted it will only be possible to withdraw your data prior to the point that the data are anonymised and only if you have provided your email address for the purpose of entering the prize draw because the otherwise the data are anonymous and cannot be linked to an individual.

What does taking part involve?

This study involves a one-off online survey which will take approximately 20 minutes. The survey will consist of the following; demographic questions, a questionnaire looking at what memory aids you typically recommend to your clients, a questionnaire looking at what you think the barriers are for use of technological memory aids for your clients and a questionnaire regarding your own familiarity with and use of technological and non-technological memory aids and your beliefs about the utility and effectiveness of such memory aids for people with dementia or mild cognitive impairment.

You will be asked to complete an online consent form prior to completing the survey. Please note this survey should only be completed on one occasion.

What happens to the information?

Please be assured that all your responses will remain confidential and if you do provide your email address to be entered into the prize draw, this information will be separated from your survey responses at the first opportunity. No link will be retained between the research data and your email address. The study data will only be available to the research team and regulators (representative of the study sponsor, NHS Greater Glasgow and Clyde,) whose job it is to check the work of researchers. The information obtained will remain confidential and stored securely on password protected University of Glasgow computers. The data will be held in accordance with the Data Protection Act 2018, which means they are kept safely. The data will be processed in compliance with General Data Protection Regulations (GDPR, 2018)

Data will be stored in archiving facilities in line with the University of Glasgow retention policy of up to 10 years. After this period, your data will be securely destroyed in accordance with relevant standard procedures.

What will happen to the results of the research study?

The results of the research study will be submitted as coursework as part of the Doctorate in Clinical Psychology (University of Glasgow). Additionally, the results may be published in a scientific journal and/or included in a scientific conference presentation. The results will also be shared with the third party organisations who assisted with distributing this survey to their members.

If you agree to provide your email address for the prize draw then you will have the option to indicate if you would like a summary of the study results.

What are the possible benefits of taking part?

There will be no direct advantage to you of taking part. By taking part in this research you will be providing valuable information to help us understand what memory aids are being recommended for people with dementia across Scotland. We will disseminate this information, which we hope will be helpful for other clinical staff who are supporting people with dementia. You will also be helping us to understand what might be the barriers to use of some memory aids, particularly electronic aids, which may help us design better aids or interventions to improve their usefulness for people with dementia.

Who has reviewed the study?

Version 4 11/12/2020

This study has been reviewed by NHS R&D management and the University of Glasgow College of Medical, Veterinary and Life Sciences Ethics Committee.

If you have any further questions?

If you would like further information about this research project please contact Katie Ferry, Dr Sally McVicar or Professor Jonathan Evans. If you wish to seek general advice about participating in this study from someone not closely linked to the study, please contact Professor Tom McMillan. Please find all contact details overleaf.

Contacts:

Mrs Katie Ferry

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Version 4 11/12/2020

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R213 Level 2, Mental Health and Wellbeing

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G12 0XH

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Email: thomas.mcmillan@glasgow.ac.uk

If you have a complaint about any aspect of the study?

If you are unhappy about any aspect of the study and wish to make a complaint, please contact the researcher in the first instance. The normal NHS complaint mechanisms are also available to you, as indicated below.

NHS Greater Glasgow & Clyde

Complaints Department

North East Sector Offices

Stobhill Hospital

300 Balgrayhill Road

Glasgow

G21 3UR

Thank-you for your time and co-operation

Appendix 2.2 Participant Consent Form

Version 4 11/12/2020

University of Glasgow

NHS Greater Glasgow and Clyde

Consent form

Title of project: A survey of memory aid recommendations made by health professionals working with people with dementia and mild cognitive impairment in Scotland

Name of researcher: Katie Ferry

Please click the box if you agree with it.

I confirm that I have read and understand the information sheet dated 11/12/20 (version 4) for the above study and have had the opportunity to ask questions. ☐

I confirm that I have read and understood the Privacy Notice dated 11/12/2020 (version 4) ☐

I understand that my participation is voluntary and that I am free to withdraw up to the point of data anonymisation, without giving any reason, without my legal rights being affected. ☐

I agree to the way my data will be collected and processed and that data will be stored for up to ten years in University archiving facilities in accordance with relevant Data Protection policies and regulations. ☐

I understand that all data and information I provide will be kept confidential and will be seen only by study researchers and regulators whose job it is to check the work of researchers. ☐

I understand that the results from the study will be shared with the third party organisations who assisted with distributing this survey to their members and may be published in a scientific journal and/or included in a scientific conference presentation. ☐

I agree to take part in this study ☐

Appendix 2.3 Participant Survey

A survey of memory aid recommendations made by clinicians working with patients with dementia and mild cognitive impairment in Scotland

Demographics

Age:

Number of years working in Older People's services:

Job title:

Familiarity and confidence in using technology

Statements	Do you agree?
I use technology in my daily life	strongly disagree ← 1 2 3 4 5 → strongly agree
I feel confident in using technology in my daily life.	strongly disagree ← 1 2 3 4 5 → strongly agree
I feel confident in recommending technology as a reminding tool to my clients (e.g. mobile phone or computer).	strongly disagree ← 1 2 3 4 5 → strongly agree
I think technology can be an effective way for people with memory problems to be reminded about things.	strongly disagree ← 1 2 3 4 5 → strongly agree
I recommended technology as a reminding tool more during COVID-19.	strongly disagree ← 1 2 3 4 5 → strongly agree
I feel more confident in recommending technology as a reminding tool since COVID-19.	strongly disagree ← 1 2 3 4 5 → strongly agree

Memory Aid Checklist

Non-technological reminders – instructions

Below is a list of memory aids, devices and strategies that are sometimes used for remembering things such as birthdays, doctor's appointments, names or everyday tasks such as shopping.

For each one, please indicate how often you typically recommend the memory aid/strategy to your clients who have dementia or Mild Cognitive Impairment, if at all.

First we want to know about simple pencil and paper or verbal reminders which you recommend:

Asking others to remind your client in person	Often	Sometimes	Very rarely	Never
A diary to help them remember things coming up in future (e.g. appointments or things to do)	Often	Sometimes	Very rarely	Never
A diary/journal to help them	Often	Sometimes	Very rarely	Never

1

remember what they have done				
Wall calendars	Often	Sometimes	Very rarely	Never
Whiteboard or wall chart	Often	Sometimes	Very rarely	Never
Making a list of things to do on a piece of paper (e.g. a things to do list or a shopping list)	Often	Sometimes	Very rarely	Never
Making notes of what they need to remember in a notebook.	Often	Sometimes	Very rarely	Never
Post-it notes	Often	Sometimes	Very rarely	Never

Technological reminders - instructions

Next, tell us about any technology (e.g. a mobile phone or computer) which you recommend to clients to remind them about things. For example, recommending that they use technology to help them to remember to go to appointments, to remember social events such as birthdays, or to help them perform everyday tasks such as shopping, cooking or cleaning?

How often do you recommend to your clients with dementia or Mild Cognitive Impairment that they use the following pieces of technology as reminding tools?

Mobile phone	Often	Sometimes	Very rarely	Never
Laptop computer or tablet computer (e.g. iPad)	Often	Sometimes	Very rarely	Never
Desktop computer	Often	Sometimes	Very rarely	Never
Television	Often	Sometimes	Very rarely	Never
Using a digital camera to take pictures of everyday events to remind them of what they have done.	Often	Sometimes	Very rarely	Never
Pager	Often	Sometimes	Very rarely	Never
Electronic personal organiser	Often	Sometimes	Very rarely	Never
Dictaphone/voice recorder	Often	Sometimes	Very rarely	Never

Alarm clock/ timer to remind them to do something	Often	Sometimes	Very rarely	Never
An internet based calendar to remind them (such as Google calendar)	Often	Sometimes	Very rarely	Never
Asking someone to send them a text message to remind them about something	Often	Sometimes	Very rarely	Never
A watch with a date/timer to remind them	Often	Sometimes	Very rarely	Never

Strategies-Instructions

Finally, tell us about other tricks, habits or strategies that you typically recommend to your clients to help them remember things.

Mental retracing of their steps - to find misplaced items (e.g. 'where did I last see the keys?'…)	Often	Sometimes	Very rarely	Never
Repetitive practice- repeating tasks until they become a habit	Often	Sometimes	Very rarely	Never
Leaving objects in places they will notice them to remind them to use them or take them with you.	Often	Sometimes	Very rarely	Never
Leaving objects in the same place so they know where to find them	Often	Sometimes	Very rarely	Never
Rhymes or phrases to remember important information (e.g. 'remember remember the 5th of November')	Often	Sometimes	Very rarely	Never
Changing passwords or PIN numbers to	Often	Sometimes	Very rarely	Never

combinations they use regularly				
Writing on their hand (or elsewhere)	Often	Sometimes	Very rarely	Never
Alphabetic searching- Considering if a name or object begins with the letter A, B , C.....etc.	Often	Sometimes	Very rarely	Never
Asking someone to send them a text message to remind them about something	Often	Sometimes	Very rarely	Never

(adapted from Evans et al, 2003 and Jamieson 2016).

Please give details here of any other memory aids or strategies which you recommend to your clients with dementia or Mild Cognitive Impairment that were not in the checklist..........

<u>Barriers to use of technological memory aids questionnaire</u>

This section concerns what you believe the barriers are to the use of technological memory aids for your clients with dementia or Mild Cognitive Impairment. This includes any technology (e.g. a mobile phone or computer) that can be used to remind your clients about things (e.g. to remember appointments or to help them perform everyday tasks such as shopping).

Statements	Do you agree?
My clients can easily access new technology	strongly disagree ← 1 2 3 4 5 → strongly agree
My clients would be able to learn how to use a new piece of technology	strongly disagree ← 1 2 3 4 5 → strongly agree
My clients find it difficult to see so it would be hard for them to see a computer screen unless it was very clear	strongly disagree ← 1 2 3 4 5 → strongly agree
My clients think technology is unsafe	strongly disagree ← 1 2 3 4 5 → strongly agree
My clients think that if people saw them using technology they would know they have a memory problem and think less of them	strongly disagree ← 1 2 3 4 5 → strongly agree
My clients would enjoy being able to show off a new piece of technology which they could use	strongly disagree ← 1 2 3 4 5 → strongly agree
I do not think my clients could understand new technology	strongly disagree ← 1 2 3 4 5 → strongly agree

My clients think if they have trouble using technology then people might think they are stupid	1 2 3 4 5 strongly disagree ←→ strongly agree
My clients prefer writing things down	1 2 3 4 5 strongly disagree ←→ strongly agree
My clients would find it difficult to afford the technology needed	1 2 3 4 5 strongly disagree ←→ strongly agree

(adapted from Jamieson (2016)

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Appendix 2.4

MVLS College Ethics Committee approval

University of Glasgow

5th January 2021

Dear Prof Evans,

MVLS College Ethics Committee

Project Title: A survey of memory aid recommendations made by clinicians working with patients with dementia and mild cognitive impairment in Scotland

Project No: 200200023

The College Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

- Project end date: As stated in application.
- The data should be held securely for a period of ten years after the completion of the research project, or for longer if specified by the research funder or sponsor, in accordance with the University's Code of Good Practice in Research: https://www.gla.ac.uk/media/media_490311_en.pdf
- The research should be carried out only on the sites, and/or with the groups defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment, except when it is necessary to change the protocol to eliminate hazard to the subjects or where the change involves only the administrative aspects of the project. The Ethics Committee should be informed of any such changes.
- You should submit a short end of study report to the Ethics Committee within 3 months of completion.
- For projects requiring the use of an online questionnaire, the University has an Online Surveys account for research. To request access, see the University's application procedure at https://www.gla.ac.uk/research/strategy/ourpolicies/useofonlinesurveystoolforresearch/.

Yours sincerely

Jesse Dawson
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Appendix 2.5 NHS GG&C R&I management approval

NHS
Greater Glasgow and Clyde

Coordinator/administrator: Kayleigh McKenna
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Website: https://www.nhsggc.org.uk/about-us/professional-support-sites/research-innovation

Research & Innovation
Dykebar Hospital, Ward 11
Grahamston Road
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Scotland, UK

01/02/2021

Mrs Katie Ferry
NHS Greater Glasgow and Clyde
Institute of Mental Health and Wellbeing
Gartnavel Royal Hospital
1055 Great Western Road
Glasgow
G12 0XH

NHS GG&C Board Approval

Dear Mrs Katie Ferry

Study Title:	A survey of memory aid recommendations made by clinicians working with patients with dementia and mild cognitive impairment in Scotland.
Principal Investigator:	Mrs Katie Ferry
GG&C HB site	Community Mental Health
Sponsor	NHS Greater Glasgow and Clyde
R&I reference:	GN20MH474
REC reference:	n/a
Protocol no: (including version and date)	V3.0 11/12/2020

I am pleased to confirm that Greater Glasgow & Clyde Health Board is now able to grant **Approval** for the above study.

Conditions of Approval

1. **For Clinical Trials** as defined by the Medicines for Human Use Clinical Trial Regulations, 2004
   a. During the life span of the study GGHB requires the following information relating to this site
      i. Notification of any potential serious breaches.
      ii. Notification of any regulatory inspections.

It is your responsibility to ensure that all staff involved in the study at this site have the appropriate GCP training according to the GGHB GCP policy (www.nhsggc.org.uk/content/default.asp?page=s1411), evidence of such training to be filed in the site file. Researchers must follow NHS GG&C local policies, including incident reporting.

2. **For all studies** the following information is required during their lifespan.
   a. First study participant should be recruited within 30 days of approval date.
   b. Recruitment Numbers on a monthly basis

Appendix 2.6 MRP Proposal

Title: A survey of memory aid recommendations made by healthcare professionals working with patients with dementia and Mild Cognitive Impairment in Scotland

Abstract

Background

Impairments in memory are common in those living with dementia. This can have a negative impact on individuals' everyday functioning and quality of life and can affect their ability to live independently. Electronic prospective memory aids have been found to increase remembering in other clinical populations; however, such tools are used infrequently by people with dementia/MCI.

Aims

This study aims to explore what memory aids clinicians working within Older People's services in Scotland are recommending to people with Mild Cognitive Impairment or Dementia. It will also look at the barriers to using technological memory aids, from the viewpoint of clinicians working with this population in Scotland.

Methods

Participants will be NHS clinicians working within Older People's services in Scotland and Alzheimer Scotland's Dementia Link Workers. Each participant will complete an online survey looking at what memory aids they recommend to people with Mild Cognitive Impairment or Dementia and what they think the barriers are to using technological memory aids for this population.

Applications

This study will indicate whether clinicians working with people with dementia/MCI typically recommend technological tools for remembering to their patients and will provide an indication of staff training needs in this area. Understanding the barriers to using technological memory aids for older people with memory problems will allow researchers to develop suitable technology for this population which may improve the quality of life for people with dementia/MCI.

Introduction

It is estimated that there are around 850,000 people in the UK presently living with dementia (Prince, 2014). Due to people living longer as result of improved healthcare and living standards, it is projected that this number will increase to one million by 2025 and two million by 2050 (Prince et al., 2014). These figures highlight the need to develop methods of supporting people with dementia to live as independently as possible for as long as possible.

One strategy which can increase the ability of people with dementia or memory problems to demlive more independently is the implementation of prospective memory aids. 'Prospective memory' (PM) describes the capability to remember to do something at some point in the future, is vital to everyday living and is vital for preserving functional independence in older people (Chasteen, Park & Schwarz, 2001). Various studies have highlighted that both people with Alzheimer's Disease and Mild Cognitive Impairment (MCI) perform significantly more poorly on PM tasks than healthy older adults without these conditions (Spindola & Brucki, 2011). Deficits in PM can have important consequences on the daily lives of people with dementia, such as forgetting to attend important appointments or forgetting to take medication (Groot, Wilson, Evans, and Watson, 2002). PM tasks can be classified into event-based tasks (e.g., take money out when you see a cash machine), time-based tasks (e.g., a GP appointment at 10:00am) and activity-based tasks where the trigger is the person's own past behaviour (e.g., take medication after lunch) (Einstein &McDaniel, 1996). Einstein, McDaniel, Richardson, Guynn & Cunfer, (1995) suggested that time-based tasks are usually harder to remember as the passage of time must be monitored and the remembering has to be self-initiated. PM tasks can also be categorised into pulse intentions, which are required to be carried out at a precise time, and step intentions which have a less specific window of time to be accomplished (Ellis, 1988).

Carrying out PM tasks relies on a variety of cognitive functions (Fish, Manly, Kopelman & Morris, 2015). Fish, Wilson and Manly (2010) highlighted that although memory for the intended action is a requirement for it to be carried out, this alone is inadequate to guarantee success in remembering. Fish et al. (2015) argued that attention and executive processes are also necessary to recognise the retrieval cue, x of time or chance to perform the intention in addition to retrieving and carrying out the intention. These processes must also compete with contemporaneous tasks which can distract attention away from the goal (Fish et al., 2015). There are also metacognitive features of PM comprising "task-specific awareness of errors, performance evaluation, and more general insight into one's PM abilities" (Fish et al., 2015, p160).

There are several kinds of memory aids, which can be classified into environmental or portable aids (Kapur, Glisky, and Wilson, 2002). Environmental aids include aids such as wall charts, alarms and leaving objects in visible places, whilst portable aids consist of aids which are always accessible such as technological devices with reminding capabilities (Caprani, Greaney and Porter, 2006). These technological reminding devices are examples of assistive devices for cognition, which refers to "any technology which compensates for cognitive deficit during task performance" (Gillespie, Best, & O'Neill, 2012, p. 2), and include smartphone applications.

As memory problems are a key feature of dementia, the use of non-technological memory aids in this population has been investigated in various studies. One such study investigating the use of external memory aids for adults with Alzheimer's disease found that portrait-style photographs and a sign with participants' name resulted in increased room finding within a nursing home setting (Nolan, Matthews & Harrison, 2001). Additionally, Bourgeois (1992) used personally relevant pictures and sentences as probes to improve the quality of dyadic conversations in adults with moderate-severe dementia.

Although the use of technological memory aids for people with dementia is in its early stages, there is some evidence that technological memory aids may be effective for this population. McGoldrick, Crawford & Evans (2019) explored the effectiveness and usability of the MindMate Smart application, which was developed to support people with Dementia, using a single-case experimental design. The two participants who successfully completed the intervention gave positive usability ratings and results indicated an improvement in memory performance (McGoldrick et al., 2019). Similarly, El Haj, Karim & Pacal (2017) found a decrease in forgetting when using Google Calendar as a reminding tool for targeted events. A recent systematic review aiming to review all randomised controlled trials (RCTs) evaluating the use of an electronic assistive device exclusively for assisting memory function in individuals with dementia found that no studies matched their inclusion criteria (Van der Roest, Wenborn, Pastink, Droes & Orrell, 2017). They identified that studies which were excluded because of the study design were due to them being longitudinal, non-randomised or single-subject designs (Van der Roest et al., 2017). The authors suggest that the lack of RCTs in this area is partly due to strict governance regulations and a lack of standardised terminology.

Despite the availability of electronic reminding devices, research suggests that a small proportion of people with dementia use them in comparison to those with an Acquired Brain Injury (ABI). A recent study indicated that whilst 75% of people surveyed with an ABI used a technological memory aid, only 38% of those with dementia did (Jamieson, 2016) However, the rates of use of non-technological memory aids were high in both groups, with 96% of those surveyed with an ABI indicating that they use them and 90% of people with dementia. It may be that the tendency towards a younger age of people with ABI in comparison to dementia partly accounts for this difference. Additionally, Jamieson (2016) found that for individuals with dementia, those who used technological tools for reminding before the onset of their memory problems were more likely to use electronic memory aids after their diagnosis. Furthermore, the people with dementia who used non-technological memory strategies were more likely to also use technology for reminding (Jamieson. 2016). The key barriers to using technological memory aids were identified as feeling incapable of using them, technology not being something they were accustomed to using and concerns that depending on technological memory aids will cause a further decline in their memory (Jamieson, 2016).

Although this previous research has gathered evidence as to the prevalence of memory aid use for people with dementia and the barriers to this, no research exploring what kind of memory aids NHS clinicians working with people with dementia tend to recommend, if any, has been undertaken. It is also unknown as to what the clinicians perceive as to the barriers of using technological memory aids for their patients. Previous research by Hart, O'Neill-Pirozzi & Morita (2003) revealed that despite beliefs that technology could be helpful for people with traumatic brain injuries, clinicians reported low levels of confidence in being able to assist their patients in using this technology, particularly if their own knowledge was limited. However, due to the more widespread use of technology, particularly smartphones, in current times, it may be that professionals are now more confident in recommending such tools to their patients. This current study will therefore investigate what technological and non-technological memory aids clinicians recommend to their patients with dementia/mild cognitive impairment and what they believe the barriers to the use of technological memory aids are for this population.

Aims

- To explore what technological and non-technological memory aids clinicians working within Older People's services in Scotland are recommending/endorsing to people with Mild Cognitive Impairment or Dementia.

- To investigate what the barriers are to the use of technological memory aids for people with Mild Cognitive Impairment or dementia, from the viewpoint of clinicians working with this population in Scotland.

It was decided to focus solely on Scotland as the organisational structures differ throughout the UK which would make UK-wide distribution challenging. Additionally, the current implementation of the Home Based Memory Rehabilitation Programme in dementia, which has been developed by NHS Scotland in partnership with Alzheimer Scotland, makes this research particularly relevant within Scotland.

Hypotheses

The key aim of this study will be to describe what memory aids clinicians recommend to patients with dementia/MCI and what they believe the barriers are. However, the following exploratory hypothesis will also be investigated:

Non-technological approaches will be recommended more frequently than technological memory aids.

The healthcare clinicians surveyed who rate themselves as more confident in using reminding technology will be more likely to recommend technology-based reminders to their patients.

Clinicians surveyed who have been qualified for longer will be less likely to recommend technology-based reminders to their patients than clinicians who qualified more recently.

Plan of investigation

Participants

Participants will be NHS clinicians working within Older People's services in Scotland and Alzheimer Scotland's Dementia Link Workers. Inclusion criteria will be that the clinician must work with people with Dementia as part of their role. It is anticipated that most of the participants will comprise of Psychologists, Occupational Therapists and Nurses. All participants will be aged 18 years and over and will be able to give informed consent to take part.

Inclusion and Exclusion Criteria

Inclusion

- Age 18 years or over
- Employed to work with people with dementia and/or MCI within Scotland as part of their role
- Able to give informed consent

Exclusion

- Clinicians who do not work with people with dementia and/or MCI

NB there is no minimum requirement in period of time/experience working with this population and will include all clinical job roles.

Recruitment Procedures

Participants will be recruited from the Older People's Community Mental Health Teams (OPCMHTs) in Scotland and Alzheimer's Scotland (Dementia Link Workers). The researcher will attempt to recruit participants from each health board in Scotland.

The survey will be distributed through the DCP Faculty of the Psychology of Older People's Scottish network and through the psychologists working within the Greater Glasgow & Clyde OPCMHTs. Additionally, the Royal College of Occupational Therapists Specialist Section (Older People) and The Royal College of Nursing Scotland will also be contacted with the aim of distributing the survey. The survey will also be distributed through Alzheimer's Scotland.

The researcher will also contact the Dementia Research Network to enquire as to whether they have a link to the OPCMHTs in Scotland which could aid distribution of the survey.

Materials

The online survey used in this study will include:

1) A demographic questionnaire (age, gender, job title, number of years working in Older People's services)
2) A memory aid checklist adapted from Evans et al. (2003) and Jamieson (2016) to be suitable for surveying clinicians working with people with dementia
3) A barriers to assistive technology use questionnaire adapted from Jamieson (2016)
4) A questionnaire regarding the clinician's own familiarity with and use of technological and non-technological memory aids and their beliefs about the utility and effectiveness of such memory aids for people with dementia or MCI

Design

This study will be a single phase cross-sectional study of health care professionals working in Older People' in Scotland. The data will be collected through an online survey.

Research Procedures

This will be a cross sectional study and an online survey will be used to recruit the participants. The online survey will be hosted by the University of Glasgow's Online Surveys tool. The target sample size is 255. As the study involves an online survey, any completed surveys will be sent directly to the researcher.

Data Analysis

This survey will use descriptive statistics to show which memory aids the participants typically recommend and the barriers to using assistive technology that they identified for the adults they work with who have dementia/mild cognitive impairment. Descriptive statistics will also be used to indicate the similarities and differences in which memory aids clinicians from the different professional groups recommend.

As Likert scales use ordinal data, a Spearman's correlation will also be used to analyse the association between the age of the respondent and how likely they are to recommend electronic memory aids to their patients (on a 5 point Likert-type scale from strongly disagree to strongly agree). A Spearman's correlation will also be used to analyse the association between the clinicians' rating of their confidence of using reminding technology themselves and how likely they are to recommend electronic memory aids to their patients.

Justification of sample size

To determine the survey sample size, the number of clinicians working in each OACMHT in NHS GG&C and Lanarkshire was calculated. Figures for 8/9 of the OPCMHTs were gathered for GG&C and 5/10 of the teams within Lanarkshire. The mean number across both teams was going to be used to estimate the number of clinicians in each team in Scotland. However, as the mean of the GG&C teams was significantly higher than those in Lanarkshire (26 vs 14.6), it was decided to use the Lanarkshire mean as this is likely to be more representative of the size of the teams in the rest of Scotland. It was established that there are around 52 teams in Scotland and so this gave an estimate of 759 clinicians in Scotland.

Using a sample size calculator (https://www.smartsurvey.co.uk/sample-size-calculator), with N=759, z (confidence interval) =95% and e (margin of error) =5%, a sample size of 255 was obtained.

Health and Safety Issues

Researcher Safety Issues

As all data collection will be completed through an online survey, there should be no risks to the researcher's safety.

Participant Safety Issues

As this is an online survey, there should be no risks to the physical safety of the participants. As the participants are NHS staff, they may be concerned as to the confidentiality of the data they share. However, all data will be anonymised and will be kept safe and secure as per the Data Protection Act (1998).

Ethical Issues

As this study will be recruiting NHS clinicians only, all participants will be able to provide informed consent.

All data collected in this study will be kept safe and secure in accordance with the Data Protection Act (1998) and the data will be processed in compliance with General Data Protection Regulations (GDPR). The data will be saved on a password protected laptop and backed up using a password encrypted USB stick. All of the survey data will be anonymised to ensure confidentiality.

The researcher will apply for approval from the University of Glasgow MVLS Ethics Committee and NHS R&D approval. As the study recruits from other health boards, I will submit an NHS to NHS proforma to each of the other health board R&D offices in order to get permission.

Financial Issues

Equipment, stationary costs etc.

As this study will use the online survey tool which is free to use, there should be no expenses as stationary will not be required due to the online nature of this study.

Timetable

End of January 2020- Original MRP proposal submitted to the University for Blind Review

June 2020- Final MRP proposal submitted

June 2020 – Submitted to University of Glasgow MVLS ethics committee

August 2020-December 2020 Data Collection (aim to recruit 128)

December 2020-April 2021 Data Collection (aim to have recruited full target)

May 2021- Data analysis

May-July 2021- Write up

End of July 2021- Final submission of MRP and Systematic Review.

Practical Applications

Due to the COVID-19 pandemic, Older Adult services have been forced to find new ways of working more remotely, likely incorporating an increased use of technology with their patients. It is therefore of interest to explore whether clinicians typically recommend technological tools for remembering to their patients and feel comfortable/knowledgeable enough to do so. Obtaining a representation of what clinicians working in Older Adult services are currently recommending to their patients will also provide an indication of where staff training needs are with regards to cognitive rehabilitation and also the need for more research into the efficacy of technological aids in this population. Additionally, investigating the barriers to using technological memory aids are for people with dementia/MCI will indicate where efforts need to be focused in developing effective tools that are suitable for people with dementia/MCI.

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Appendix 2.7 Jamieson (2016) memory aid use checklist

Non-technological reminders - instructions

Below is a list of memory aids, devices and strategies that are sometimes used for remembering things such as birthdays, doctor's appointments, names or everyday tasks such as shopping.

For each one, please indicate;

1. Tick a box to indicate if you used the memory aid before your brain injury.

2. Tick a box to indicate if you use the memory aid now.

3. Tick one box to indicate how often you use it (monthly, weekly or daily).

4. Tick one box to indicate how useful the aid or strategy is for you.

First we want to know about simple pencil and paper or verbal reminders which you use:

Items

Asking others to remind you in person

A diary to help you remember things coming up in future (e.g. appointments or things to do)

A diary/journal to help you remember what you have done

Wall calendars

Whiteboard or wall chart

Making a list of things to do on a piece of paper (e.g. a things to do list or a shopping list)

Making notes of what you need to remember in a notebook.

Post-it notes

Technological reminders - instructions

Next, tell us about any technology (e.g. a mobile phone or computer) which you use to remind yourself about things. For example, do you use technology to help you remember to go to appointments, to remember social events such as birthdays, or to help you perform everyday tasks such as shopping, cooking or cleaning?

Please only tick the boxes if you have used or currently use this technology to help you remember things – many people will use a mobile phone as a phone but only tick the box if you use it to help you remember things.

Items

Mobile phone to remind you

Laptop computer or tablet computer (e.g. iPad) to remind you

Desktop computer to remind you

Television (e.g. automatic prompting about or recording of favourite shows)

Using a camera to take pictures of a holiday or special occasion to help you remember it afterwards.*

Using a digital camera to take pictures of everyday events to remind you of what you have done.

A pager to remind you

Electronic personal organiser

Dictaphone/ voice recorder to remind you

Alarm clock to wake up*

Alarm clock/ timer to remind you to do something

An internet based calendar to remind you (such as Google calendar)

Asking someone to send you a text message you to remind you about something

A watch with a date/timer to remind you

If you use any of these technological memory aids, what do you use them to remind you about?

*These items were not included in analysis as the function of reminding was not prompted. These items were added to prevent people from reporting that they used camera or alarm to remind them, when they really only used them to take pictures on holiday or wake up.

<u>Strategies – instructions</u>

Finally, tell us about other tricks, habits or strategies do you use to remind yourself of things

<u>Items</u>

Mental retracing of your steps - to find misplaced items (e.g. 'where did I last see the keys?'…)

Repetitive practice- repeating tasks until they become a habit

Leaving objects in places you will notice them to remind you to use them or take them with you.

Leaving objects in the same place so you know where to find them

Rhymes or phrases to remember important information (e.g. 'remember remember the 5th of November')

Changing passwords or PIN numbers to combinations you use regularly

Writing on your hand (or elsewhere)

Alphabetic searching- Considering if a name or object begins with the letter A, B , C.....etc.

Please give details here of any other memory aids or strategies which you use that were not in the checklist.

Appendix 2.8 Jamieson (2016) barriers to assistive technology use questionnaire

I find it difficult to use technology because my hands shake (physical)	1 2 3 4 5 strongly disagree ←→ strongly agree
Using technology would make me feel like I had a problem (reverse effects)	1 2 3 4 5 strongly disagree ←→ strongly agree
Having a phone which send me reminders all the time would invade my privacy (ethical)	1 2 3 4 5 strongly disagree ←→ strongly agree
I have always kept up to date with new technology (personal preferences)	1 2 3 4 5 strongly disagree ←→ strongly agree
It feels like a step forward if I remember things myself without relying on technology to remind me (beliefs about memory)	1 2 3 4 5 strongly disagree ←→ strongly agree
I have difficulty hearing, so it would be difficult for me to be reminded by an alarm sound (physical)	1 2 3 4 5 strongly disagree ←→ strongly agree
If I tried to use technology and failed I would feel like I couldn't do anything (reverse effects)	1 2 3 4 5 strongly disagree ←→ strongly agree

If people saw me using technology they would know I had a memory problem and think less of me (emotional)	1 2 3 4 5 strongly disagree ←→ strongly agree
I would enjoy being able to show off a new piece of technology which I could use (emotional)	1 2 3 4 5 strongly disagree ←→ strongly agree
I don't think I could understand new technology (cognitive)	1 2 3 4 5 strongly disagree ←→ strongly agree
If I had trouble using technology then people might think I was stupid (emotional)	1 2 3 4 5 strongly disagree ←→ strongly agree
I prefer writing things down (personal preferences)	1 2 3 4 5 strongly disagree ←→ strongly agree
After I forgot something important, I felt like I should use technology to help me remember (beliefs about memory)	1 2 3 4 5 strongly disagree ←→ strongly agree