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[Intervention Review]

Cognitive rehabilitation for memory deficits after stroke

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ABSTRACT

Background

Memory problems are a common cognitive complaint following stroke and can potentially affect ability to complete functional activities. Cognitive rehabilitation programmes either attempt to retrain lost or poor memory functions, or teach patients strategies to cope with them.

Some studies have reported positive results of cognitive rehabilitation for memory problems, but the results obtained from previous systematic reviews have been less positive and they have reported inconclusive evidence. This is an update of a Cochrane review first published in 2000 and most recently updated in 2007.

Objectives

To determine whether participants who have received cognitive rehabilitation for memory problems following a stroke have better outcomes than those given no treatment or a placebo control.

The outcomes of interest were subjective and objective assessments of memory function, functional ability, mood, and quality of life. We considered the immediate and long-term outcomes of memory rehabilitation.

Search methods

We used a comprehensive electronic search strategy to identify controlled studies indexed in the Cochrane Stroke Group Trials Register (last searched 19 May 2016) and in the Cochrane Central Register of Controlled Trials (CENTRAL2016, Issue 5), MEDLINE (2005 to 7 March 2016), EMBASE 2005 to 7 March 2016), CINAHL (2005 to 5 February 2016), AMED (2005 to 7 March 2016), PsycINFO (2005 to 7 March 2016), and nine other databases and registries. Start dates for the electronic databases coincided with the last search for the previous review. We handsearched reference lists of primary studies meeting the inclusion criteria and review articles to identify further eligible studies.

Selection criteria

We selected randomised controlled trials in which cognitive rehabilitation for memory problems was compared to a control condition. We included studies where more than 75% of the participants had experienced a stroke, or if separate data were available from those with stroke in mixed aetiology studies. Two review authors independently selected trials for inclusion, which was then confirmed through group discussion.

Data collection and analysis

We assessed study risk of bias and extracted data. We contacted the investigators of primary studies for further information where required. We conducted data analysis and synthesis in accordance with the *Cochrane Handbook for Systematic Reviews of Interventions*. We performed a 'best evidence' synthesis based on the risk of bias of the primary studies included. Where there were sufficient numbers of similar outcomes, we calculated and reported standardised mean differences (SMD) using meta-analysis.

Main results

We included 13 trials involving 514 participants. There was a significant effect of treatment on subjective reports of memory in the short term (standard mean difference (SMD) 0.36, 95% confidence interval (CI) 0.08 to 0.64, $P = 0.01$, moderate quality of evidence), but not the long term (SMD 0.31, 95% CI -0.02 to 0.64, $P = 0.06$, low quality of evidence). The SMD for the subjective reports of memory had small to moderate effect sizes.

The results do not show any significant effect of memory rehabilitation on performance in objective memory tests, mood, functional abilities, or quality of life.

No information was available on adverse events.

Authors' conclusions

Participants who received cognitive rehabilitation for memory problems following a stroke reported benefits from the intervention on subjective measures of memory in the short term (i.e. the first assessment point after the intervention, which was a minimum of four weeks). This effect was not, however, observed in the longer term (i.e. the second assessment point after the intervention, which was a minimum of three months). There was, therefore, limited evidence to support or refute the effectiveness of memory rehabilitation. The evidence was limited due to the poor quality of reporting in many studies, lack of consistency in the choice of outcome measures, and small sample sizes. There is a need for more robust, well-designed, adequately powered, and better-reported trials of memory rehabilitation using common standardised outcome measures.

PLAIN LANGUAGE SUMMARY

Cognitive rehabilitation for memory deficits after stroke

Review question

We reviewed the evidence for the effectiveness of cognitive rehabilitation for memory problems in people with stroke.

Background

People often struggle with memory problems following stroke and this can lead to difficulties in everyday life. The degree and kind of memory problems, mood changes, and performance of everyday activities can vary widely depending on many factors, including the location of the stroke in the brain, severity, age, and the previous health of the person experiencing a stroke.

Memory rehabilitation, a part of cognitive rehabilitation, is a therapeutic activity that may play a role in the recovery of memory functions, or in enabling the individual to adapt to the problems. Memory rehabilitation is a standard part of rehabilitation in many settings. However, it is uncertain whether memory rehabilitation can improve people's memory problems, or whether it has an effect on mood, performance in everyday activities, or quality of life.

Study characteristics

The evidence is current to May 2016. In this review, we included 13 studies with 514 participants. Seven trials were conducted with community participants, four with in-patients, and two with mixed community and in-patient samples. Participants received various types of memory retraining techniques, including training using computer programs and training in the use of memory aids, such as diaries or calendars. In three studies treatment was provided in groups and in 10 studies treatment was provided individually. Treatment lasted between two weeks and 10 weeks. In these studies, those who received the treatment were compared with a control group. The control group included those who did not receive cognitive rehabilitation or received another form of treatment. The control groups varied. Some studies had a control group wherein people received their usual care, whereas in others individuals in the control groups were placed on a waiting list to receive cognitive rehabilitation.

Key results

We found that people who received cognitive rehabilitation reported fewer memory problems in daily life immediately after treatment compared with the control groups. This represents a small to moderate effect of the intervention in comparison to the control group. However, there was no evidence that the benefits persisted in the long term. We found no evidence that cognitive rehabilitation improved people's independence in activities of daily living, mood, or quality of life. There was no information about any harm caused to participants from taking part in cognitive rehabilitation.

Quality of the evidence

The quality of the evidence ranged from very low (effect on outcomes that relate to everyday activities) to moderate (effect on self-reported memory problems, memory tests, and mood measures). There were a number of flaws in these studies, such as having very few people in them, and these could have affected our findings.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

Cognitive rehabilitation for memory deficits following stroke						
Patient or population: patients with memory deficits following stroke Setting: multiple - hospital, outpatient, community; worldwide Intervention: memory training Comparison: no memory training or alternative training						
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Quality of the evidence (GRADE)	Comments
	Risk with no memory training	Risk with memory training				
Subjective memory measures (immediate outcome) Assessed with: Metamemory in Adulthood Questionnaire, EMQ, Memory Questionnaire, Memory Assessments Clinics rating scale, Memory Functioning Questionnaire (frequency of forgetting - carer), CAPM self, CFQ Follow-up: range 4 weeks to 5 months	-	The mean for subjective memory measures (immediate outcome) in the intervention group was 0.36 standard deviations higher (0.08 to 0.64 higher)	-	215 (7 RCTs)	⊕⊕⊕○ MODERATE ¹	SMD of 0.36, based on Cohen's interpretation of effect size, would represent a small to moderate effect
Subjective memory measures (long-term outcome) Assessed with: Metamemory in Adulthood Ques-	-	The mean for subjective memory measures (long-term outcome) in the intervention group was 0.31 standard deviations higher (0.02	-	149 (3 RCTs)	⊕⊕○○ LOW ²	SMD of 0.31, based on Cohen's interpretation of effect size, would represent a small to moderate effect

tionnaire, EMQ, Memory Assessments Clinics rating scale Follow-up: range 3 months to 7 months		lower to 0.64 higher)				
Objective memory measures (immediate outcome) - comprehensive batteries Assessed with: RBMT, WMS Follow-up: range 6 weeks to 5 months	-	The mean for objective memory measures (immediate outcome) - comprehensive batteries in the intervention group was 0.25 standard deviations higher (0.36 lower to 0.86 higher)	-	91 (5 RCTs)	⊕○○○ VERY LOW ³	SMD of 0.25, based on Cohen's interpretation of effect size, would represent a small to moderate effect
Objective memory measures (immediate outcome) - verbal memory sub-tests Assessed with: RBMT story recall, 15 words test, RAVLT delayed, Claeson-Dahl delayed Follow-up: range 4 weeks to 12 weeks	-	The mean for objective memory measures (immediate outcome) - verbal memory sub-tests in the intervention group was 0.21 standard deviations higher (0.03 lower to 0.46 higher)	-	266 (5 RCTs)	⊕⊕⊕○ MODERATE ⁴	SMD of 0.21, based on Cohen's interpretation of effect size, would represent a small effect
Objective memory measures (long-term outcome) - comprehensive batteries Assessed with: RBMT Follow-up: range 18 weeks to 7 months	-	The mean for objective memory measures (long-term outcome) - comprehensive batteries in the intervention group was 0.17 standard deviations lower (0.74 lower to 0.41 higher)	-	49 (3 RCTs)	⊕⊕○○ LOW ⁵	SMD of 0.17, based on Cohen's interpretation of effect size, would represent a small effect

<p>Functional ability measures (immediate outcome) Assessed with: FIM, EADL, unspecified functional independence measure Follow-up: range 4 weeks to 5 months</p>	-	<p>The mean for functional ability measures (immediate outcome) in the intervention group was 1.17 standard deviations higher (0.35 lower to 2.68 higher)</p>	-	<p>164 (3 RCTs)</p>	<p>⊕○○○ VERY LOW ⁶</p>	<p>SMD of 1.17, based on Cohen's interpretation of effect size, would represent a large effect</p>
<p>Mood measures (immediate outcome) Assessed with: GHQ, HADS-D, CES-D Follow-up: range 6 weeks to 5 months</p>	-	<p>The mean for mood measures (immediate outcome) in the intervention group was 0.07 standard deviations undefined lower (0.35 lower to 0.21 higher)</p>	-	<p>194 (3 RCTs)</p>	<p>⊕⊕⊕○ MODERATE ⁷</p>	<p>SMD of 0.07, based on Cohen's interpretation of effect size, would represent a small effect</p>
<p>Mood measures (long-term outcome) Assessed with: GHQ, HADS-D, CES-D Follow-up: range 18 weeks to 7 months</p>	-	<p>The mean for mood measures (long-term outcome) in the intervention group was 0.17 standard deviations lower (0.54 lower to 0.19 higher)</p>	-	<p>175 (3 RCTs)</p>	<p>⊕⊕⊕○ MODERATE ⁸</p>	<p>SMD of 0.17, based on Cohen's interpretation of effect size, would represent a small effect</p>
<p>Quality of life measures (immediate outcome) Assessed with: EQ-5D Utility and VAS scores Follow-up: 6 weeks</p>	-	<p>There were no statistically significant differences in the mean quality of life measures (immediate outcome) between the intervention and control groups on the Utility score (Intervention: m = 0.76; SD 0.26; Control: m = 0.76; SD 0.25; P = 1.00; d = 0),</p>	-	<p>141 (1 RCT)</p>	<p>⊕⊕⊕○ MODERATE ⁹</p>	<p>Effect size of 0, based on Cohen's interpretation of effect size, would represent no effect, and 0.15 would represent a small effect</p>

		or the VAS score (Intervention: m = 67.89; SD 16.61; Control: m = 70.23; SD 15.67; P = 0.39; d = 0.15)				
Quality of life measures (long-term outcome) Assessed with: EQ-5D Utility and VAS scores Follow-up: 6 months	-	There were no statistically significant differences in the mean quality of life measures (long-term outcome) between the intervention and control groups on the Utility score (Intervention: m = 0.76; SD 0.26; Control: m = 0.78; SD 0.22; P = 0.63; d = 0.08), or the VAS score (Intervention: m = 68.38; SD 17.94; Control: m = 71.51; SD 13.61; P = 0.25; d = 0.19)	-	134 (1 RCT)	⊕⊕⊕○ MODERATE ¹⁰	Effect size of 0.08 and 0.19, based on Cohen's interpretation of effect size, would represent a small effect

*The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

CAPM: Comprehensive Assessment of Prospective Memory; **CES-D:** Center for Epidemiological Studies Depression Scale; **CFQ:** Cognitive Failures Questionnaire; **CI:** confidence interval; **EADL:** Nottingham Extended Activities of Daily Living; **EMQ:** Everyday Memory Questionnaire; **FIM:** Functional Independence Measure; **GHQ:** General Health Questionnaire; **HADS-D:** Hospital Anxiety and Depression Scale - Depression; **OR:** odds ratio; **RAVLT:** Rey Auditory Verbal Learning Test; **RBMT:** Rivermead Behavioural Memory Test; **RCT:** randomised controlled trial; **RR:** risk ratio; **SD:** standard deviation; **VAS:** visual analogue scale; **WMS:** Wechsler Memory Scale

GRADE Working Group grades of evidence

High quality: we are very confident that the true effect lies close to that of the estimate of the effect

Moderate quality: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low quality: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect

Very low quality: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

¹Downgraded one level due to serious study limitations (four of the seven included studies had two areas with high risk of bias, alongside several unclear judgements).

²Downgraded two levels in total. Downgraded one level due to serious study limitations (one of the three included studies had two areas with high risk of bias), and one level due to indirectness (two of the three included studies used mixed diagnoses samples). Despite some asymmetry in the forest plot, there was no further downgrading for any suspected publication bias as this was likely to be accounted for by the small number of participants with stroke in otherwise large mixed diagnoses studies.

³Downgraded three levels in total. Downgraded one level due to inconsistency (I^2 statistic of 42%), one level due to indirectness (four of the five included studies used mixed diagnoses samples), and one due to imprecision (wide confidence intervals for this outcome).

⁴Downgraded one level due to serious study limitations (four of the five included studies had two areas with high risk of bias, alongside several unclear judgements).

⁵Downgraded two levels due to indirectness (two of the three studies used mixed diagnoses samples, and all three had very small sample sizes).

⁶Downgraded four levels in total. Downgraded one level due to serious study limitations (there were a number of unclear judgements, specifically in [Chen 2006](#)), one level due to inconsistency (I^2 statistic of 93%), one level due to indirectness (the interventions in [Chen 2006](#) and [Zucchella 2014](#) included only a minor aspect of memory rehabilitation), and one level due to imprecision (confidence intervals for this outcome include both a null effect and an appreciable benefit).

⁷Downgraded one level due to serious study limitations (two of the three included studies had two areas with high risk of bias).

⁸Downgraded one level due to serious study limitations (two of the three included studies had two areas with high risk of bias).

⁹Downgraded one level due to serious study limitations (the included study had two areas with high risk of bias).

¹⁰Downgraded one level due to serious study limitations (the included study had two areas with high risk of bias).

BACKGROUND

Description of the condition

Memory impairment occurs after stroke (Lincoln 2012), and can persist over many years (Schaapsmeeders 2013). A systematic review of the prevalence of memory impairment after stroke estimated that between 23% and 55% have memory impairment three months after stroke and between 11% and 31% a year after stroke (Snaphaan 2007). A review of subjective cognitive complaints after stroke indicated that many stroke patients report problems with memory in daily life (van Rijsbergen 2014), and complaints about memory problems are more frequent than complaints about impairment in other cognitive domains (Lamb 2013). These cognitive impairments have been shown to have a negative effect on the patient's functional independence (Middleton 2014).

Description of the intervention

Cognitive rehabilitation is a "systematic, functionally oriented service of therapeutic activities that is based on assessment and understanding of the patient's brain-behavioural deficits" (Cicerone 2005). Memory rehabilitation is a component of this generic cognitive rehabilitation. Such rehabilitation facilitates the development of behavioural and cognitive strategies that have, as their goal, a positive impact on the structural and functional recovery of the damaged brain, and improve the quality of life of the individual in general (Robertson 2001).

Traditionally, memory rehabilitation has focused on teaching patients the use of internal aids (such as mnemonics, rehearsal, and mental imagery) and external memory aids (such as the use of diaries, notice boards, and lists) to help them remember and recall information. In addition, rehearsal is employed to attempt to restore memory function.

How the intervention might work

There is uncertainty about the precise mechanisms of how memory rehabilitation interventions work. However, it is widely believed that interventions work by providing people with information about their memory problems, by teaching them the use of internal and external memory aids, by training people to use different strategies to pay attention, and alternative ways of encoding, storing, and retrieving information. Targeted, repeated stimulation of certain brain areas using 'drill and practice' cognitive exercises is thought to trigger the activation of neural networks. For group-based interventions, the therapeutic effects of being with others with similar problems may also help. Some of these behavioural strategies (referred to as 'restitution' or 'compensation') are believed to map onto the neural networks engaged in performing memory functions.

Why it is important to do this review

The effectiveness of memory rehabilitation after stroke has been examined by studies using different methodologies. Single-case and small group studies have reported positive results of memory rehabilitation, but the results obtained from some systematic reviews have been less positive and they have reported inconclusive evidence. Cicerone 2011 suggested that teaching patients to use external memory aids (including assistive devices) with direct application to functional activities was recommended as a practice guideline in people with severe memory impairment after traumatic brain injury or stroke, but the evidence for other strategies for those with stroke is limited. Gillespie 2015 highlighted the fact that there is very little strong evidence for the effectiveness of rehabilitation for cognitive deficits found after stroke, and concluded that very few direct clinical recommendations could be made. A similar conclusion was reached by Cumming 2013. This is an update of a Cochrane review first published in 2000 and most recently updated in 2007 (das Nair 2007).

OBJECTIVES

To determine whether participants who have received cognitive rehabilitation for memory problems following a stroke have better outcomes than those given no treatment or a placebo control.

The outcomes of interest were subjective and objective assessments of memory function, functional ability, mood, and quality of life. We considered the immediate and long-term outcomes of memory rehabilitation.

METHODS

Criteria for considering studies for this review

Types of studies

For inclusion in the review, we sought randomised controlled trials, as defined by the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), and the pre-cross-over component of randomised cross-over trials with participants who have had a stroke, in which a memory treatment is compared with a control. Where publications were based on the same sample, or sub-set of a larger sample, we only included the study with the full sample to avoid double counting.

Types of participants

We confined trials included in this review to those with people who had memory deficits following stroke (based on a clinical definition as defined by the trialists). Thus, we excluded trials that included participants whose memory deficits were the result of traumatic brain injury, brain tumour, multiple sclerosis, epilepsy, or any other neurological condition unless at least 75% of the sample had a stroke, or a stroke subgroup could be identified for which there were separate data, or such data could be obtained from the study authors. Memory deficits were not defined in advance, but we assumed that those patients given treatment for impaired memory had memory deficits. We placed no restrictions on the types of memory deficits participants reported.

Types of interventions

We included trials in which there was a comparison between a treatment group that received one of various memory rehabilitation strategies, and a control group that received either an alternative form of treatment or no memory intervention.

We considered memory rehabilitation to be any attempt to modify memory function by means of 'drill and practice', or by the use of internal or external memory aids, or by teaching patients strategies to cope with their memory problems. We did not include drug studies.

We considered memory rehabilitation that took place over more than a single session. Therefore, we did not consider laboratory-based experiments (such as single session list-recall or mnemonic strategy training) to be cognitive rehabilitation.

Types of outcome measures

Primary outcomes

Primary outcomes were measures of the extent of memory problems in everyday life. If there was more than one outcome measure measuring this construct in a study, we used the following hierarchy of commonly used tests that assess subjective reports of memory function: Everyday Memory Questionnaire (EMQ) (Sunderland 1983), Subjective Memory Questionnaire (Davis 1995), Memory Assessment Clinics Questionnaire (Crook 1992), Internal and External Memory Aids Questionnaires, Cognitive Failures Questionnaire (Broadbent 1982).

Secondary outcomes

- Objective reports of memory. Rivermead Behavioural Memory Test (RBMT) (Wilson 1985 or newer versions of this test), Wechsler Memory Scale (WMS) (Wechsler 1997 or newer versions of this test), Cambridge Test of Prospective Memory (Wilson 2005), Doors and People Memory Test (Baddeley 1994).

- The hierarchies of measures of memory function above were based on the tests' degree of sensitivity to assess everyday memory problems. For objective assessments, where the outcomes were not in the above hierarchy, general memory test scores were used over verbal memory, which were used over visual memory. If there were other outcome measures used that were not in this hierarchy, we arrived at a consensus following discussion regarding which measures to consider as the primary outcome measure, before the statistical analyses were conducted, so as to minimise bias.

- We used both total scores and individual domain scores, as appropriate. Domain scores were included as some tests (such as the Doors and People Test, Baddeley 1994) do not provide a total score, but only domain-specific scores. In the event that several types of scores were reported for various outcomes, we used the following hierarchy: total profile scores over index scores (indices) or composite scores over subtest scores.

- Measures of functional abilities, such as the Nottingham Extended Activities of Daily Living (EADL) (Nouri 1987), Functional Independence Measure (FIM) (Hamilton 1987), Functional Assessment Measure (FAM) (Hall 1997), Barthel Index (Mahoney 1965).

- Mood, such as the General Health Questionnaire (GHQ) (Goldberg 1988), Hospital Anxiety and Depression Scale (HADS) (Zigmond 1983), Beck Depression Inventory-Fast Screen (Beck 2003), Beck Anxiety Inventory (Beck 1990), Wimbledon self-report scale (Coughlan 1988).

- Quality of life, such as the Stroke Impact Scale (Duncan 1999), Stroke Specific Quality of life scale (Williams 1999), SF-36 (Ware 2001), WHO-QoL (WHOQoL 1993).

If more than one measure was used for each domain, then tests were included in the priority order listed above.

We classified all outcomes as immediate or longer-term and we conducted separate analyses for each of these. We defined immediate outcomes as shortly after the end of intervention, and longer-term outcomes as the second outcome following the immediate outcome.

Search methods for identification of studies

See the 'Specialized register' section in the [Cochrane Stroke Group](#) module. We searched for trials in all languages and, where necessary, arranged translation of relevant papers published in languages other than English.

Electronic searches

We searched the Cochrane Stroke Group Trials Register, which was last searched by the Managing Editor on 19 May 2016. In addition, we searched the following electronic databases.

- Cochrane Central Register of Controlled Trials (CENTRAL 2016, Issue 5) (from 2005) ([Appendix 1](#)).
- MEDLINE (Ovid) (2005 to 7 March 2016) ([Appendix 2](#)).
- EMBASE (Ovid) (2005 to 7 March 2016) ([Appendix 3](#)).
- Cumulative Index to Nursing and Allied Health Literature (CINAHL) (EBSCO host) (2005 to 5 February 2016).
- Allied and Complementary Medicine Database (AMED) (2005 to 7 March 2016).
- PsycINFO (2005 to 7 March 2016).
- ClinicalTrials.gov (www.clinicaltrials.gov/) (5 February 2016).
- World Health Organization (WHO) International Clinical Trials Registry Portal (<http://apps.who.int/trialsearch/>) (8 February 2016).
- The NIHR Clinical Research Network database (<http://public.ukcrn.org.uk/>) (8 February 2016).
- UK CRN Study Portfolio (8 February 2016).
- Latin American and Caribbean Health Science Information Database (LILACS) (Bireme) (1982 to 8 February 2016).
- CAB Abstracts (2005 to 7 March 2016).
- REHABDATA (www.naric.com/research/rehab/) (5 February 2016).
- Stroke Trials Registry (www.strokecenter.org/trials/) (5 February 2016).
- ISRCTN Registry (<http://www.isrctn.com/>) (5 February 2016).

Start dates for the electronic databases coincided with the last search for the previous review. Two review authors (HC, EW) identified potential studies.

Searching other resources

Handsearching

In an effort to identify trials not included in the electronic databases, we handsearched the following journals in 1999 for the first version of this review.

- *American Journal of Occupational Therapy* (1947 to 1998).
- *Aphasiology* (1987 to 1998).
- *Australian Occupational Therapy Journal* (1965 to 1998).
- *British Journal of Occupational Therapy* (1950 to 1998).
- *British Journal of Therapy and Rehabilitation* (1994 to 1998).
- *Canadian Journal of Occupational Therapy* (1970 to 1998).
- *Clinical Rehabilitation* (1987 to 1998).
- *Disability Rehabilitation* (1992 to 1998), formerly *International Disability Studies* (1987 to 1991), formerly *International Rehabilitation Medicine* (1979 to 1986).
- *International Journal of Language & Communication Disorders* (1998), formerly *European Journal of Disorders of Communication* (1985 to 1997), formerly *British Journal of Disorders of Communication* (1977 to 1984).

- *International Journal of Rehabilitation Research* (1977 to 1998).
- *Journal of Clinical Psychology in Medical Settings* (1994 to 1998), formerly *Journal of Clinical Psychology* (1944 to 1994).
- *Journal of Developmental and Physical Disabilities* (1992 to 1998), formerly *Journal of the Multihandicapped Person* (1989 to 1991).
- *Journal of Rehabilitation* (1963 to 1998).
- *Journal of Rehabilitation Science* (1989 to 1996).
- *Neuropsychological Rehabilitation* (1987 to 1998).
- *Neurorehabilitation* (1991 to 1998).
- *Occupational Therapy International* (1994 to 1998).
- *Physiotherapy Theory and Practice* (1990 to 1998), formerly *Physiotherapy Practice* (1985 to 1989).
- *Physical Therapy* (1988 to 1998).
- *Rehabilitation Psychology* (1982 to 1998).
- *Journal of Cognitive Rehabilitation* (1988 to 1998), formerly *Cognitive Rehabilitation* (1983 to 1987).

The 1999 handsearch included a broad range of journals, as it covered searches for trials in four areas of rehabilitation. For the 2006 update, we checked the Master List of journals searched by Cochrane (<http://www.cochrane.us/masterlist.asp>).

We did not handsearch any scientific journals for this update as relevant trials were found from the search of the Cochrane Central Register of Controlled Trials (CENTRAL), for which handsearching is carried out periodically, and we did not wish to duplicate this effort.

Citation tracking of all primary study articles, and scanning reference lists from book chapters and review articles, provided an additional search strategy.

Data collection and analysis

Selection of studies

One review author (RdN), in consultation with a senior librarian, developed the electronic search strategy. Two review authors (HC, EW) evaluated the abstracts of the studies obtained by this search strategy and identified trials for inclusion in the review using four inclusion criteria (types of trials, participants, interventions, and outcome measures).

Another review author (NBL) cross-checked the search strategy and confirmed the inclusion and exclusion of studies.

Data extraction and management

We conducted the review using RevMan 5 ([RevMan 2014](#)).

We used the data extraction tool employed in the previous version of this review ([das Nair 2007](#)), which is similar to that proposed by the CONSORT statement ([Moher 2010](#)). Two review authors

(HC, EW) extracted and cross-checked study characteristics and outcomes.

We recorded the following information for each trial.

- Methods: number of sites, unit of allocation, timing of outcomes.
- Participants: country, setting, method of stroke diagnosis, age, time since onset, loss to follow-up.
- Interventions: content, duration, frequency.
- Outcomes: measures used.

If these data were not available or were unclear from the reports, we contacted the first author of the trial for further information. Where studies were not available in the English language, we had them translated into English by someone fluent in the language.

Assessment of risk of bias in included studies

Two authors (HC, EW) independently assessed the methodological quality of the included trials and completed 'Risk of bias' tables as described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

The table includes the following items:

- Random sequence generation.
- Allocation concealment.
- Blinding (of participants, personnel and outcome assessors).
- Incomplete outcome data.
- Selective outcome reporting.
- Other biases (e.g. attrition bias, design flaws).

We judged these aspects on the basis of the information provided in the studies or, if this information was not available or was unclear from the reports (particularly relating to the randomisation procedure) we contacted the first author of the trial for further information. Two review authors completed ratings for each domain as being low or high risk of bias, or 'unclear' if sufficient information was not available, according to the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). A third review author (NBL) arbitrated any disagreements. None of the review authors were blinded to the names of the study authors, institutions, or the publishing journal of the included trials, as two of the review authors (RdN and NBL) work in this area and are familiar with the studies published in memory rehabilitation, and therefore could not be blinded.

Measures of treatment effect

We used the standardised mean difference (SMD) with 95% confidence intervals (CI) for the continuous outcomes.

Unit of analysis issues

We considered for inclusion parallel-group, cross-over, and cluster-RCTs, and included the data from all of these types of studies (where available) in the meta-analyses. For cross-over studies,

we only included the pre-cross-over phase of the trials. We did not combine the first and second phases of the cross-over studies because of uncertainty about the carryover effects in such trials, given that they are psychological interventions, where the wash-out period is difficult to determine. For cluster-RCTs, our analyses followed the *Cochrane Handbook for Systematic Reviews of Interventions* recommendation (16.3.4) (Higgins 2011). We included trials with more than two intervention or control groups and analysed them by pooling together the data from all of the experimental groups and comparing these with the control group. If there was more than one control group, we pooled the results from these.

Dealing with missing data

Where data were not available or were unclear from the reports, we contacted the corresponding author of the study in question for further information. We rated studies as high risk of bias if they had a post-randomisation attrition rate of 30% or more (even if an intention-to-treat analysis was used).

Assessment of heterogeneity

We assessed heterogeneity by comparing the distribution of important participant factors between trials (age, gender, type of stroke), and trial factors (sequence generation, allocation concealment, blinding, losses to follow-up). We used the I^2 statistic to statistically assess heterogeneity (Higgins 2011). We further scrutinised the studies to explore reasons for the heterogeneity if the I^2 statistic was significant at $\geq 50\%$.

Assessment of reporting biases

We assessed reporting bias by comparing the published paper with any published protocol, or with any raw data for the study provided by the study authors on request.

Data synthesis

We consulted the *Cochrane Handbook for Systematic Reviews of Interventions* to plan the data synthesis and we followed the procedures outlined therein (Higgins 2011). As most psychological and neuropsychological outcome measures in memory rehabilitation tend to be ordinal level measures, we treated these as continuous data (as recommended by Higgins 2011). We used the SMD as a summary statistic as we predicted that multiple trials would employ various outcome measures to assess memory. If low scores represented a better outcome, we changed the valence of the score from positive (+) to negative (-). In situations where studies combined scores from scales in which high scores were in some instances good and in some instances poor outcomes, we reversed the signs of the discrepant scores to keep them consistent. For the meta-analysis we only considered data that we deemed to be similar or comparable enough to meaningfully pool on the basis of the

outcome measures employed. Depending on the heterogeneity of the data, we considered fixed-effect or random-effects models.

GRADE and 'Summary of findings' table

We summarised an evaluation of the overall risk of bias, based on the relative importance of the various domains listed. In addition to the 'Risk of bias' table, we used the GRADE approach to assess the quality of the studies ([GRADEpro](#)). We completed this process across outcomes ([Summary of findings for the main comparison](#)). This approach allowed for judgements to be made about the quality of the studies included in each outcome, so that any conclusions could be drawn from the outcome and the quality of studies included in that outcome. Where studies had two or more categories graded as high risk of bias we downgraded the quality by one grade.

Subgroup analysis and investigation of heterogeneity

We considered subgroup analysis according to type of intervention (group versus individual cognitive rehabilitation).

Sensitivity analysis

We considered sensitivity analyses to assess the impact of study quality (whether there was a difference between studies employing an intention-to-treat analysis and those using on-treatment analysis) where data to perform such analyses were available from the included papers. We also considered a sensitivity analysis to assess the influence of methodological quality on the intervention effect for each outcome by comparing the outcomes of those trials with low risk of bias with all the included studies.

RESULTS

Description of studies

Results of the search

The previous version of this review identified two studies. For this update, we identified a total of 4934 articles. We carried out preliminary screening on the basis of information obtained from the titles of the articles; we excluded 3400 after we had removed duplicates. We examined abstracts for the 298 studies selected and obtained full papers if the abstracts suggested that they might satisfy the inclusion criteria.

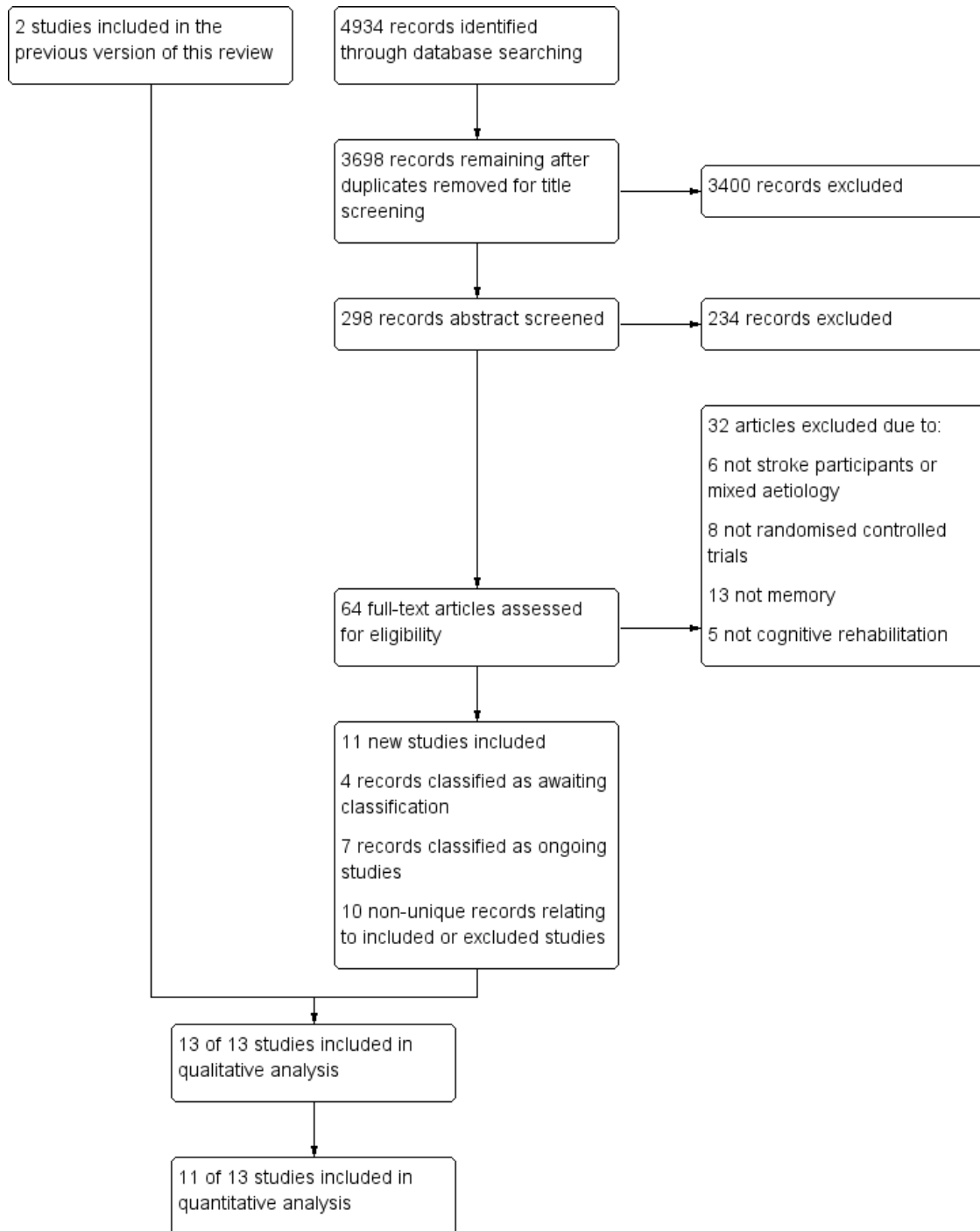
From the 64 articles, 10 were non-unique and related to other studies otherwise discussed in this review, and we classified seven as ongoing. Ongoing studies were those still recruiting participants (n = 5), or the analyses were not yet available with no response from the authors (n = 2). These studies are presented in the [Characteristics of ongoing studies](#) table.

We classified studies where only conference proceedings or abstracts with no full paper were available as awaiting classification (n = 4), which are presented in the [Characteristics of studies awaiting classification](#) table.

We formally excluded a total of 32 papers according to our review criteria that were: not stroke participants, or groups of participants with different diagnoses without separate data available for those with stroke (n = 6); not an RCT (n = 8); not a memory study (n = 13); and not a cognitive rehabilitation study (n = 5).

We added the two studies from the previous review to the 11 new studies in the final analysis ([Figure 1](#)).

Figure 1. Flow diagram showing article screening process for updated search



See the [Characteristics of included studies](#) table for more details of the 13 included studies.

Included studies

Study location

The 13 included studies were based in the following countries: Australia ([Lannin 2014](#); [Radford 2012](#)), China ([Chen 2006](#); [Lin 2014](#)), Italy ([Zucchella 2014](#)), the Netherlands ([Aben 2014](#); [Doornhein 1998](#)), Russia ([Prokopenko 2013](#)), Sweden ([Åkerlund 2013](#); [Westerberg 2007](#)), the UK ([das Nair 2012](#)), and the USA ([Lemoncello 2011](#)). One was a multi-centre study involving seven centres in Europe ([Kaschel 2002](#)).

Seven trials included community participants ([Aben 2014](#); [Åkerlund 2013](#); [das Nair 2012](#); [Lemoncello 2011](#); [Lin 2014](#); [Radford 2012](#); [Westerberg 2007](#)), four trials included in-patients ([Chen 2006](#); [Doornhein 1998](#); [Prokopenko 2013](#); [Zucchella 2014](#)), and two included both community and in-patient participants ([Kaschel 2002](#); [Lannin 2014](#)).

Participant characteristics

The number of participants with stroke in the studies varied from four ([Lemoncello 2011](#)) to 153 ([Aben 2014](#)). The number of participants with stroke in the treatment or control groups varied from one ([Lemoncello 2011](#)) to 77 ([Aben 2014](#)). Varied gender ratios were reported, with the percentage of men ranging from 50% ([Radford 2012](#)) to 75% ([Lemoncello 2011](#)). Mean ages of stroke participants ranged from 31 years ([Lannin 2014](#)) to 68 years ([Zucchella 2014](#)), and the mean time since participants' stroke onset ranged from less than one month ([Prokopenko 2013](#); [Zucchella 2014](#)) to 91 months ([Lannin 2014](#)).

In four studies participants were diagnosed with stroke using neuroimaging (positron emission tomography (PET), computed tomography (CT) or magnetic resonance imaging (MRI)) ([Chen 2006](#); [Lannin 2014](#); [Westerberg 2007](#); [Zucchella 2014](#)), in one this was described as a confirmed diagnosis ([Lin 2014](#)), and one used clinical neurological examination ([Prokopenko 2013](#)). The method of diagnosis of stroke was not stated in seven studies ([Aben 2014](#); [Åkerlund 2013](#); [das Nair 2012](#); [Doornhein 1998](#); [Lannin 2014](#); [Lemoncello 2011](#); [Radford 2012](#)), but participants were recruited from rehabilitation medicine outpatient clinics, specialist brain injury rehabilitation centres, and community rehabilitation groups, or were referred by neurologists, speech and language pathologists, or acquired brain injury specialists.

There were seven studies that included only participants with stroke ([Aben 2014](#); [Chen 2006](#); [Doornhein 1998](#); [Lin 2014](#); [Prokopenko 2013](#); [Westerberg 2007](#); [Zucchella 2014](#)), none that

included more than 75% with stroke in a mixed aetiology sample, and six that were mixed aetiology samples for which separate data were available for those with stroke ([Åkerlund 2013](#); [das Nair 2012](#); [Kaschel 2002](#); [Lannin 2014](#); [Lemoncello 2011](#); [Radford 2012](#)). In the studies with participants with various diagnoses, the proportion with stroke ranged from 68% ([Åkerlund 2013](#)) to 12% ([Lannin 2014](#)).

The groups were comparable on assessed baseline characteristics in eight studies ([Aben 2014](#); [Åkerlund 2013](#); [das Nair 2012](#); [Doornhein 1998](#); [Lin 2014](#); [Prokopenko 2013](#); [Westerberg 2007](#); [Zucchella 2014](#)). This information was not available for four studies ([Chen 2006](#); [Kaschel 2002](#); [Lemoncello 2011](#); [Radford 2012](#)), and in one study there was an imbalance in time since onset but this was considered unlikely to affect outcomes ([Lannin 2014](#)).

Study design

Seven studies used standard rehabilitation or usual care as a control group ([Åkerlund 2013](#); [Chen 2006](#); [Lannin 2014](#); [Lemoncello 2011](#); [Lin 2014](#); [Prokopenko 2013](#); [Westerberg 2007](#)), one used a waiting list control ([Radford 2012](#)), two used alternative forms of memory rehabilitation ([Doornhein 1998](#); [Kaschel 2002](#)), and three used a non-memory related attention (placebo) control ([Aben 2014](#); [das Nair 2012](#); [Zucchella 2014](#)).

Treatment characteristics

The structure and contents of the treatment programmes were diverse. Three studies provided group treatment ([Aben 2014](#); [das Nair 2012](#); [Radford 2012](#)), and 10 provided individual interventions ([Åkerlund 2013](#); [Chen 2006](#); [Doornhein 1998](#); [Kaschel 2002](#); [Lannin 2014](#); [Lemoncello 2011](#); [Lin 2014](#); [Prokopenko 2013](#); [Westerberg 2007](#); [Zucchella 2014](#)). The contents of the group treatment programmes included education and teaching of compensatory strategies. Individual treatments included computerised memory training in five studies ([Åkerlund 2013](#); [Lin 2014](#); [Prokopenko 2013](#); [Westerberg 2007](#); [Zucchella 2014](#)), strategy training in two studies ([Chen 2006](#); [Doornhein 1998](#)), imagery mnemonics in one study ([Kaschel 2002](#)), and the use of external memory aids in two studies ([Lannin 2014](#); [Lemoncello 2011](#)).

Four studies provided interventions lasting between eight and 10 weeks ([das Nair 2012](#); [Kaschel 2002](#); [Lannin 2014](#); [Lin 2014](#)), in six studies treatment lasted between four and six weeks ([Aben 2014](#); [Åkerlund 2013](#); [Doornhein 1998](#); [Radford 2012](#); [Westerberg 2007](#); [Zucchella 2014](#)), in two studies treatment was delivered in two weeks ([Lemoncello 2011](#); [Prokopenko 2013](#)), and for one study this was not clear ([Chen 2006](#)). Each session lasted between 30 minutes for computerised training ([Åkerlund 2013](#); [Prokopenko 2013](#)), and up to two hours for group treatments ([Radford 2012](#)).

Outcomes assessed

A range of outcome measures were used by the included studies. Subjective measures of memory were used in six studies (Doornhein 1998; das Nair 2012; Kaschel 2002; Lannin 2014; Radford 2012; Westerberg 2007). Each study used a different questionnaire measure. Objective memory abilities were assessed in 11 studies. Chen 2006 used the Loewenstein Occupational Therapy Cognitive Assessment (LOTCA) as a measure of cognitive abilities but this does not include an assessment of memory. Lemoncello 2011 did not use any objective measures. Of the 11 studies, six studies used a battery of memory tests, the Rivermead Behavioural Memory Test (RBMT; Åkerlund 2013; das Nair 2012; Kaschel 2002; Lannin 2014), the Wechsler Memory Scale (Lin 2014), and the Montreal Cognitive Assessment (MoCA) (Prokopenko 2013). Five studies used measures of verbal learning, such as the RBMT Story Recall (Aben 2014), Rey AVLT (RAVLT) (Radford 2012; Zucchella 2014), 15 word test (Doornhein 1998), and the Word list recall (Westerberg 2007). Three studies examined whether their rehabilitation programme had an effect on functional abilities and all used different measures (das Nair 2012; Prokopenko 2013; Zucchella 2014). Four studies assessed mood (Aben 2014; Åkerlund 2013; das Nair 2012; Prokopenko 2013). All used different measures. Quality of life was assessed in only two studies (Aben 2014; Prokopenko 2013). Each used different measures.

Conclusions from individual studies

Six studies included data from mixed diagnoses groups and therefore there were no specific conclusions for those with stroke (Åkerlund 2013; das Nair 2012; Kaschel 2002; Lannin 2014; Lemoncello 2011; Radford 2012). Of the seven studies that included only those with stroke (Aben 2014; Chen 2006; Doornhein 1998; Lin 2014; Prokopenko 2013; Westerberg 2007; Zucchella 2014), the conclusions suggested some beneficial effect of memory rehabilitation in five studies (Aben 2014; Chen 2006; Lin 2014; Westerberg 2007; Zucchella 2014). Two studies reported beneficial effects on subjective memory questionnaires (Aben 2014; Westerberg 2007), but neither of these reported any significant effects on memory abilities. One study reported beneficial effects on memory ability but not functional abilities (Zucchella 2014). One study reported beneficial effects on functional abilities but did not assess memory abilities (Chen 2006). One study reported

significant improvement in memory in the intervention group but not the control group, but did not report a direct comparison (Lin 2014). Two studies reported no significant effects of intervention (Doornhein 1998; Prokopenko 2013).

Excluded studies

On the basis of the exclusion criteria specified for this review, we formally excluded 32 studies on the following criteria.

Six did not meet the criteria for stroke. One study had only one participant with a stroke (Ownsworth 1999), one did not include any participants with stroke in a mixed brain injury sample (Thoene 1995), and four had mixed diagnosis groups where separate data for those with stroke could not be obtained (de Joode 2013; de Luca 2014; Lundqvist 2010; McDonald 2011).

Eight studies were not RCTs. Two studies had no control group (Klonoff 2007; Sohlberg 2007), two studies used alternate allocation based on performance (Hildebrandt 2006; Tailby 2003), one study did not allocate all participants randomly (Miller 2014), and one study used a matched pairs design (Fong 2009).

Thirteen studies did not investigate memory difficulties. Four studies covered executive functioning (Bushnick 2010; Chen 2011; Skidmore 2015, Man 2006), and four studies focused on attention (Barker-Collo 2009; Blanchet 2016; Chen 2015; Schupp 2002). Four studies evaluated cognitive orientation to daily occupational performance (CO-OP; McEwan 2014; McEwan 2015; Polatajko 2012; Wolf 2015), and one motor function (Liu 2009). Four studies did not provide cognitive rehabilitation (Brainin 2015; Markle-Reid 2011; Rasmussen 2016; Yu 2009), and one compared methods of delivery of cognitive rehabilitation (Gamito 2014).

We excluded four studies from the previous version of this review (Evans 2000; Gasparini 1979; Imes 1984; Wilson 2001), and these were not included in the results of the search for this update.

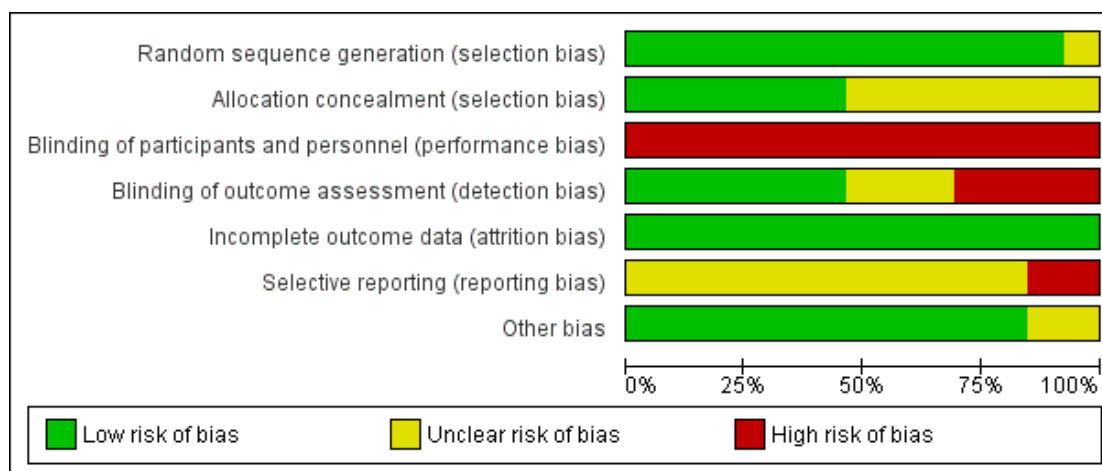
Risk of bias in included studies

We used the data extraction tool described above to assess the quality of the studies considered for inclusion. We paid particular attention to the randomisation, treatment allocation concealment and blinding procedures, and the flow of participants through the trial. See Figure 2 and Figure 3.

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Aben 2014	+	+	-	+	+	-	+
Åkerlund 2013	+	?	-	?	+	-	+
Chen 2006	+	?	-	?	+	?	+
das Nair 2012	+	+	-	+	+	?	+
Doornhein 1998	?	?	-	-	+	?	?
Kaschel 2002	+	+	-	?	+	?	?
Lannin 2014	+	+	-	+	+	?	+
Lemoncello 2011	+	?	-	-	+	?	+
Lin 2014	+	?	-	+	+	?	+
Prokopenko 2013	+	?	-	+	+	?	+
Radford 2012	+	+	-	-	+	?	+
Westerberg 2007	+	+	-	-	+	?	+
Zucchella 2014	+	?	-	+	+	?	+

Figure 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Allocation

We judged 12 studies to have adequate random sequence generation. We judged one study as being unclear as the study authors reported that participants were assigned at random with no further detail provided (Doornhein 1998).

We judged six studies to have adequate allocation concealment with randomisation into groups using a computerised system (Radford 2012), a sealed envelope system (Lannin 2014; Westerberg 2007), or having a separate staff member who was not further involved in the study to complete allocation (Aben 2014; das Nair 2012; Kaschel 2002).

Blinding

In all studies the participants and those delivering the intervention were aware of the allocation, suggesting a high risk of performance bias.

Six studies had observer-blinded assessment of outcomes (Aben 2014; das Nair 2012; Lannin 2014; Lin 2014; Prokopenko 2013; Zucchella 2014). We considered four studies to have high risk of bias because those delivering the intervention also conducted the outcome assessments (Doornhein 1998; Lemoncello 2011; Radford 2012; Westerberg 2007). Three studies were unclear in their description of the methods used (Åkerlund 2013; Chen 2006; Kaschel 2002).

Incomplete outcome data

We deemed incomplete outcome data to be a low risk in 11 studies. In four studies all participants completed the outcome assessments (Doornhein 1998; Lannin 2014; Lin 2014; Prokopenko 2013); in seven studies the attrition rates provided were comparable between groups (Aben 2014; das Nair 2012; Kaschel 2002; Lemoncello 2011; Radford 2012; Westerberg 2007; Zucchella 2014). This information was not clear for two studies (Åkerlund 2013; Chen 2006). No studies had more than 30% attrition.

Selective reporting

We deemed selective reporting to be a high risk of bias in two studies (Aben 2014; Åkerlund 2013). Aben 2014 did not report the EQ-5D Utility score, only the visual analogue scale (VAS) score. Åkerlund 2013 only reported on some memory outcomes, whereas there were other outcomes that were also assessed at follow-up, and data were only reported for 'good adherers' to the intervention.

Other potential sources of bias

We did not identify any other sources of bias.

Effects of interventions

See: [Summary of findings for the main comparison](#)

For the meta-synthesis, we only included data from 11 of the 13 included studies, based on the data that were available. We summarised the outcomes under the domains of subjective memory, objective memory, functional abilities, mood, and quality of life. When pooling the data, we used a random-effects model because these were studies performed on a heterogeneous group of participants, with the intervention (being a complex intervention) being slightly different between studies (e.g. number of sessions). This would allow us to generalise our findings to most memory rehabilitation interventions offered for people who have had a stroke.

Outcome 1: Subjective memory measures

Subjective measures of memory were used in seven studies ([Aben 2014](#); [Doornhein 1998](#); [das Nair 2012](#); [Kaschel 2002](#); [Lannin 2014](#); [Radford 2012](#); [Westerberg 2007](#)), of which three included long-term follow-up ([Aben 2014](#); [das Nair 2012](#); [Kaschel 2002](#)). The various subjective memory measures used were: Metamemory in Adulthood Questionnaire, Everyday Memory Questionnaire, Memory Questionnaire, Memory Assessments Clinics rating scale, Memory Functioning Questionnaire (frequency of forgetting - carer), Comprehensive Assessment of Prospective Memory self, and the Cognitive Failures Questionnaire. There was a significant effect of treatment on subjective reports of memory in the short term (standardised mean difference (SMD) 0.36, 95% confidence interval (CI) 0.08 to 0.64, $P = 0.01$; [Analysis 1.1](#)), but not the long term (SMD 0.31, 95% CI -0.02 to 0.64, $P = 0.06$; [Analysis 1.2](#)). We observed no statistical heterogeneity in the short- or longer-term analyses ($Tau^2 = 0.00$; $Chi^2 = 5.69$, $df = 6$ ($P = 0.46$); $I^2 = 0\%$ and $Tau^2 = 0.00$; $Chi^2 = 0.73$, $df = 2$ ($P = 0.69$); $I^2 = 0\%$).

Outcome 2: Objective memory measures

Ten studies included data on objective measures of memory immediately after treatment ([Aben 2014](#); [Åkerlund 2013](#); [das Nair 2012](#); [Doornhein 1998](#); [Kaschel 2002](#); [Lannin 2014](#); [Lin 2014](#); [Radford 2012](#); [Westerberg 2007](#); [Zucchella 2014](#)), and four of these studies examined long-term effects of treatment ([Aben 2014](#); [Åkerlund 2013](#); [das Nair 2012](#); [Kaschel 2002](#)). Several objective memory measures were used, including comprehensive batteries (Rivermead Behavioural Memory Test, Wechsler Memory Scale) and verbal memory sub-tests (Rivermead Behavioural Memory Test story recall, 15 words test, Rey Auditory Verbal Learning Test delayed, Claeson-Dahl delayed). There were no significant differences found between intervention and control groups on either immediate or long-term follow-up on either memory test batteries (SMD 0.25, 95% CI -0.36 to 0.86, $P = 0.43$ and SMD -0.17, 95% CI -0.74 to 0.41, $P = 0.57$, respectively; [Analysis 1.3](#); [Analysis 1.4](#)). The I^2 statistic was 42% for objective memory assessed by a comprehensive battery immediately after intervention. On the

verbal learning task, there was no significant difference between groups immediately after treatment (SMD 0.21, 95% CI -0.03 to 0.46, $P = 0.08$). Data from only one study were available in relation to long-term verbal learning outcome and this was therefore not included in the meta-analysis ([Aben 2014](#)).

Outcome 3: Functional abilities (activities of daily living: ADL)

Three studies included measures of participants' function in terms of ADL immediately after treatment ([Chen 2006](#); [das Nair 2012](#); [Zucchella 2014](#)), and one study in the long term ([das Nair 2012](#)). The Functional Independence Measure, Extended Activities of Daily Living scale and an unspecified independence measure were used as the outcome measures of ADL. There was no significant effect of treatment on functional ability immediately after treatment (SMD 1.17, 95% CI -0.35 to 2.68, $P = 0.13$; [Analysis 1.5](#)). The I^2 statistic suggested significant statistical heterogeneity at 93%. Data from only one study were available in relation to long-term functional outcome and this was therefore not included in the meta-analysis.

Outcome 4: Mood

Three studies included measures of participants' mood immediately after treatment and at long-term follow-up ([Aben 2014](#); [Åkerlund 2013](#); [das Nair 2012](#)). Mood was measured on the General Health Questionnaire, Hospital Anxiety and Depression Scale (depression sub-scale) and the Centre for Epidemiological Studies Depression scale. No effect of treatment was found on mood either immediately (SMD -0.07, 95% CI -0.35 to 0.21, $P = 0.63$; [Analysis 1.6](#)), or on long-term follow-up (SMD -0.17, 95% CI -0.54 to 0.19, $P = 0.35$; [Analysis 1.7](#)). There was no statistical heterogeneity at immediate or long-term follow-up ($Tau^2 = 0.00$; $Chi^2 = 0.66$, $df = 2$ ($P = 0.72$); $I^2 = 0\%$ and $Tau^2 = 0.02$; $Chi^2 = 2.40$, $df = 2$ ($P = 0.30$); $I^2 = 17\%$).

Outcome 5: Quality of life

Only one study included measures of participants' quality of life (assessed on the EQ-5D) immediately after treatment and at long-term follow-up ([Aben 2014](#)). Therefore, we did not enter this into the meta-analysis. There were no statistically significant differences in the mean quality of life measures (immediate outcome) between the intervention and control groups on the Utility score (intervention: $m = 0.76$; standard deviation (SD) 0.26; control: $m = 0.76$; SD 0.25; $P = 1.00$; $d = 0$), or the visual analogue scale (VAS) score (intervention: $m = 67.89$; SD 16.61; control: $m = 70.23$; SD 15.67; $P = 0.39$; $d = 0.15$); or in the long term on the Utility score (intervention: $m = 0.76$; SD 0.26; control: $m = 0.78$; SD 0.22; $P = 0.63$; $d = 0.08$), or the VAS score (intervention: $m = 68.38$; SD 17.94; control: $m = 71.51$; SD 13.61; $P = 0.25$; $d = 0.19$).

DISCUSSION

Summary of main results

Overall, the results suggested a beneficial effect of memory rehabilitation on subjective reports of memory problems in daily life immediately after treatment. However, no statistically significant effects of treatment were observed on these outcomes at longer-term follow-up. Similarly, no statistically significant differences were observed between groups on objective memory abilities immediately after intervention or long-term as assessed by comprehensive memory batteries, or immediately as assessed on verbal learning tasks. No statistically significant differences were observed on measures of mood or functional abilities, either immediately after the intervention or on long-term follow-up. We could not assess the impact of memory rehabilitation on quality of life as only one study had assessed this outcome.

Therefore, it appears that memory rehabilitation has a positive effect on subjective reports of memory problems in people who have had a stroke. This, however, was not substantiated by the findings from the objective tests of memory (either as a comprehensive test battery or as a verbal learning task). This discrepancy might suggest that people 'feel' that they have improved, with no actual change to their memory function, because they have learnt to cope with their memory problems. Often, subjective reports of memory are associated with mood (Lamb 2013; van Rijsbergen 2014), but this was not evident from our review. Another interpretation is that the subjective and objective measures of memory assess two different aspects of memory. The significant effect of memory rehabilitation on subjective memory measures was strongly influenced by results from one study that had a large sample size (Aben 2014). These results will remain tentative until there are more large studies.

There was a lack of consistency in the outcome domains assessed. While many studies included measures of subjective memory problems, mood, and functional abilities, they rarely used the same measure. Several objective memory measures were used, and often the primary outcome was not clearly specified by the trialists. Indeed, many studies suffered from poor quality of reporting, particularly failing to state the procedures for randomisation, allocation concealment, blinding, and reasons for loss to follow-up. Most trialists did not comply with the CONSORT guidelines in reporting their trial (Moher 2001). The obvious result of such failings was the lack of clarity in discerning the methods of the study. Another major concern was the degree of clinical and methodological heterogeneity that trials in memory rehabilitation possess. Without trials explicitly elucidating methodological procedures, heterogeneity cannot be adequately addressed. Furthermore, although statistical heterogeneity was not evident in most of the analyses, on two outcomes it was in the low to moderate range, and on one outcome it was high. We were unable to conduct a thorough inspection of the cause of this heterogeneity because of the small sample size and small number of studies. However, we

suspect that it may have been caused because many trials used multiple tests of objective memory function (with comprehensive batteries having several different sub-tests, each measuring a different component of memory). In addition, in all trials both participants and therapists were aware of the group to which they were allocated. This is difficult to avoid in trials of cognitive rehabilitation, but may lead to some bias.

The results of this review suggest that there is some evidence to support the effectiveness of memory rehabilitation for subjective memory impairments immediately after treatment, but these benefits are not maintained at long-term follow-up. Overall, there was insufficient evidence to support or refute the effectiveness of cognitive rehabilitation for memory ability, mood, independence in activities of daily living, or quality of life.

Overall completeness and applicability of evidence

There are limitations to this review. Many of the studies identified included samples with mixed diagnoses, and although several study authors provided separate data for those with stroke, the sample sizes were small. A sensitivity analysis could have been conducted to compare the stroke-only studies with those with stroke patients as part of a mixed diagnosis group, but given that most trials had small samples further fractionating may have led to further reduction in power, which we felt would lead to inconclusive findings. Mixed diagnoses studies are beneficial in determining the potential for the generalisability of training programmes across diagnostic groups and reflect usual clinical practice in many centres, but there are likely to be differential effects of the training based on diagnosis and even severity (Cicerone 2000). This is an area that requires further investigation.

Quality of the evidence

These findings are limited due to the small number of studies included for each outcome and the small sample sizes. The evidence was limited due to poor quality of reporting in many studies and lack of consistency in the choice of outcome measures. Furthermore, as seen from the GRADE quality ratings, we rated most studies as being of moderate quality. Downgrading was typically due to serious study limitations, where we had assessed studies as having two or more areas with a high risk of bias. Other reasons for downgrading were wide confidence intervals, small sample sizes, mixed diagnosis groups, and inconsistency (large I^2 values).

Potential biases in the review process

Two authors (RdN, NBL) conducted one of the trials included in the review (das Nair 2012). To mitigate bias, study selection and

data extraction were undertaken by the two review authors not involved in any of the included trials.

Agreements and disagreements with other studies or reviews

Our findings are similar to two previous reviews (Cumming 2013; Gillespie 2015), which highlighted the paucity of evidence for the effectiveness of cognitive rehabilitation after stroke and they are consistent with the previous Cochrane review (das Nair 2007), in that there was insufficient evidence to support or refute the effectiveness of memory rehabilitation on most outcomes. However, unlike the previous Cochrane review, this review found evidence to suggest that there was a beneficial effect of cognitive rehabilitation for memory on subjective measures of memory in the short term.

AUTHORS' CONCLUSIONS

Implications for practice

Given that a large number of individuals complain of memory problems following a stroke, and considering that some centres are offering a variety of interventions to address these problems, questioning the effectiveness of these treatment programmes is pertinent. The studies examined in this review reflected the diversity of intervention strategies employed in memory rehabilitation, and variation in outcome measures used to evaluate their effectiveness. In this review, we found some evidence to suggest that memory rehabilitation was more effective than no rehabilitation or control.

However, our results indicate that any benefits of memory rehabilitation were limited to improvements in subjective reports of memory function in the short term and they are inconclusive for long-term follow-up.

Implications for research

The evidence base for the effectiveness of cognitive rehabilitation for memory problems following stroke, from the literature surveyed, appears weak. Few randomised controlled trials (RCTs) have been reported, and many had methodological flaws inherent in the study design. There was an increased risk of random errors due to sampling errors and small sample sizes, an over-reliance and misinterpretation of significance tests (without mention of confidence intervals), problems related to poor (or absent) reporting of randomisation procedures, poor (or absent) blinding, differences in the nature of the outcomes measured, and overall poor quality of reporting of trials. The results of this review suggest that there is an urgent need for further well-conceptualised, executed, and reported RCTs of memory rehabilitation for people who have had a stroke, which take into consideration some of the issues raised in this review.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[author-defined order]*

Aben 2014

Methods	<p>Multi-site RCT</p> <p>Participants block randomised (10 per site) by randomisation programme to intervention group (I) or control group (C; attention control)</p> <p>Outcomes assessed at 4 points: 3 weeks prior to intervention (T0), 10 days after last intervention session (T1), 6 months post baseline (T2) and 12 months post baseline (T3)</p>
Participants	<p>The Netherlands</p> <p>Community</p> <p>Memory impairment assessed using subjective interviews to identify memory complaints</p> <p>Method of stroke diagnosis not stated, but study recruited from 2 rehabilitation centres</p> <p>At randomisation n = 153</p> <p>I: n = 77</p> <p>Mean age: 58.3 (10.36), 33/44 (female/male)</p> <p>Mean time (months) since onset 52.41 (39.38)</p> <p>42 LH, 35 RH; 54 ischaemic, 23 not stated</p> <p>C: n = 76</p> <p>Mean age 57.86 (9.00), 36/40 (female/male)</p> <p>Mean time (months) since onset 55.34 (35.08)</p> <p>45 LH, 31 RH; 50 ischaemic, 26 not stated</p> <p>Lost to follow-up: at T1 n = 10 (5 I, 5 C; sample n = 72 I, 71 C) with ITT analysis, at T2 n = 1 (1 I, 1 C participants previously lost returned with measures; sample n = 71 I, 72 C), T3 n = 4 (4 I, 0 C, sample n = 67 I, 72 C)</p>
Interventions	<p>Compensatory approach, plus psycho-education and CBT aspects</p> <p>I: 9 x 1-hour sessions/twice weekly (9 hours total). Groups of 4 to 6. Memory Self Efficacy training programme covering: 1) theoretical introduction on memory and stroke, 2) training on internal and external memory strategies to improve compensation, 3) psycho-education on effect of mood, anxiety and memory-related worries on memory complaints. Training booklet provided plus half-hour homework per session</p> <p>C: 9 x 1-hour sessions/twice weekly (9 hours total). Groups of 4 to 6. Peer support groups, no therapeutic intervention. Education on causes and consequences of stroke; sharing of problems. Hand-outs provided, but no homework assigned</p>
Outcomes	<p>Subjective memory measure: Metamemory In Adulthood questionnaire</p> <p>Objective memory measure: RBMT story recall delayed</p> <p>Mood measure: CES-D</p> <p>Quality of life measure: EQ-5D Utility</p> <p>Other outcomes assessed:</p> <p>Health-related quality of life (WHOQoL-Bref; EQ-5D - VAS), Memory (AVLT), Social Support List, problem experience (Impact on Participation and Autonomy)</p>

Notes	<p>Inclusion criteria: > 18 month post-onset of first and only stroke, 18 to 80 years old, living independently, reported subjective memory complaints (via interview)</p> <p>Exclusion criteria: progressive neurological disorder (e.g. dementia or MS), insufficient knowledge and comprehension of Dutch, alcohol/drug abuse, subdural haematoma or subarachnoid haemorrhage</p> <p>Adequate matching: demographics and baseline characteristics non-significant on most measures</p> <p>Method of diagnosing stroke: not stated, but recruited from 2 rehabilitation centres</p> <p>Coping, personality traits, aphasia and executive functioning measures were taken at baseline only</p> <p>Statistical tests used: independent t-tests for continuous variables and χ^2 tests for categorical variables using baseline data for MSE and z-scores for AVLT and RBMT</p> <p>Short-term follow-up data also presented in Aben 2013 paper, which used an ITT analysis on T1 results</p>	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation conducted by someone independent to the trial, using a randomisation program
Allocation concealment (selection bias)	Low risk	"Allocation of the group to either the experimental or control condition was performed by an independent investigator who was not involved in the study"
Blinding of participants and personnel (performance bias) All outcomes	High risk	"Patients were not informed on the type of intervention they had been allocated to". Those delivering intervention were aware
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"All patients were assessed [...] by trained research psychologists who were blinded to group allocation. The data were entered [...] by the blinded research psychologists."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Missing outcome data explained and equal in both groups
Selective reporting (reporting bias)	High risk	No protocol available to cross-check. However, 2 additional published papers show same outcome measures with equal participants in each. From the EQ-5D only the VAS score was reported, but not the Utility score

Other bias	Low risk
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Åkerlund 2013

Methods	<p>RCT between March 2008 and December 2010</p> <p>Single site</p> <p>Participants randomised by lot to an intervention group (I) or a waiting-list control group (C)</p> <p>Outcomes assessed at 3 time points: T0 baseline (pre-randomisation), T1 6 weeks post-baseline (1 week following end of intervention sessions) and T2 18 weeks post baseline (13 weeks following end of intervention sessions)</p>
Participants	<p>Sweden</p> <p>Community (out-patients)</p> <p>Mixed diagnoses group with n = 29 stroke participants (whole group n = 47)</p> <p>Method of diagnosis of stroke not specified, but participants recruited through a department of rehabilitation</p> <p>Memory problems identified through performance below normal range (6 ± 1) on WAIS-III Digit span and/or Span board</p> <p>Undergoing T0, T1 and T2 assessments (n = 29):</p> <p>I: n = 15</p> <p>Mean age: 45.93 (11.27), 9/6 (female/male)</p> <p>Mean time (months) since onset: 7.44 (2.59)</p> <p>5 LH, 10 RH</p> <p>C: n = 14</p> <p>Mean age: 52.86 (7.48), 8/6 (female/male)</p> <p>Mean time (months) since onset: 6.40 (3.21)</p> <p>7 LH, 6 RH</p> <p>Lost to follow-up: 3 (n = 32 at randomisation)</p>
Interventions	<p>Both groups received standard rehabilitation</p> <p>I: trained 30 to 45-minute session, 5 days/week for 5 weeks with a computerised WM training program, Cogmed QM (a battery of visuospatial and verbal auditory WM tasks). All parts of the battery trained at each session, over 90 trials each day. All Cogmed tasks involved: (1) maintenance of multiple stimuli at the same time, (2) short delays during which representation of stimuli should be held in WM, (3) unique sequencing of stimuli order in each trial, (4) difficulty level adapting as individual performance</p> <p>Program provides continuous feedback and reinforcement</p> <p>Additional personal and individual feedback once a week, by a specially trained coach</p> <p>C: completed baseline and follow-up assessments only. Cogmed was offered, and followed up, after study completion</p>
Outcomes	<p>Objective memory measure: RBMT Profile Score</p> <p>Mood measure: Hospital Anxiety and Depression Scale: HADS-D</p> <p>Other outcomes assessed: WM and information processing (Span board and Digit span sub-tests of WAIS-III NI), working memory sub-scale (aggregated from combined scaled-scored results of Digit span, Arithmetic and Letter-Number Sequences of WAIS-III NI), cognitive function (Barrow Neurological Institute Screen for Higher Cerebral Functions;</p>

	BNIS), executive function (Dysexecutive Questionnaire; DEX), psychological health (anxiety, HADS-A)	
Notes	<p>Inclusion criteria: patients below normal range (6 ± 1) with a performance of ≤ 5 digits forwards and/or ≤ 4 digits reversed in the WAIS-III Digit span and/or ≤ 5 blocks forwards and/or ≤ 4 blocks reversed in the WAIS-III NI Span board</p> <p>Exclusion criteria: aphasia/non-Swedish speaking, participation in study contraindicated due to medical reasons (according to physician's health assessment, i.e. pronounced fatigue, pain or depression)</p> <p>Adequate matching at baseline, only a small age difference between groups</p> <p>Statistical tests used: Mann-Whitney U-test, independent samples, for ordinal data and Chi^2 test for nominal data for between-group differences. Wilcoxon signed-rank test for within-group differences. Spearman's Rank correlation for associations between variables</p> <p>RBMT data provided by authors as unpublished data</p>	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"After a baseline assessment the patients were randomised by lot into either the intervention group or the control group."
Allocation concealment (selection bias)	Unclear risk	No indication of who conducted allocation - however, baseline assessments were conducted before randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel knew of allocation
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not stated whether outcome assessors were blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	3 randomised but not followed up. Reasons for attrition not specified for stroke sample
Selective reporting (reporting bias)	High risk	No published protocol available, however additional data provided by authors includes RBMT and Fatigue Impact Scale (FIS)
Other bias	Low risk	

Chen 2006

Methods	RCT between August 2003 and April 2005 Inpatient (rehabilitation and neurology) Single site Participants randomised using a random number generator to either the intervention group (I) or a TAU control group (C) Outcomes assessed at 2 time points: T0 baseline and T1 post-treatment
Participants	China Method of determining memory problems, stroke diagnosis and time since stroke onset not stated At randomisation (n = 60): I: n = 30 Mean age: 62.12 (6.98), 14/16 (female/male) 14 LH, 16 RH; haemorrhage 13, infarction 17 C: n = 30 Mean age: 63.60 (7.43), 12/18 (female/male) 12 LH, 18 RH; haemorrhage 15, infarction 15
Interventions	I: TAU plus cognitive retraining according to impairments (attention/concentration, memory, coping strategies for apraxia and memory) C: TAU - physiotherapy, occupational therapy
Outcomes	Functional independence measure: scale name not stated Other outcomes assessed: cognitive (Loewenstein occupational therapy cognitive assessment; LOTCA), motor (Fugl Meyer motor assessment; FMS)
Notes	Inclusion criteria: met national infarction and haemorrhage guidelines 1995, CT and MRI scan results, first time illness, aged 45 to 70 years, stable illness, one-sided paralysis, secondary school education or above Exclusion criteria: serious cardiac problems, serious speech impairment Original paper published in Chinese and translated by a staff member of the lead author's department

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Random number generator"
Allocation concealment (selection bias)	Unclear risk	Unsure who conducted the allocation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and therapists knew about allocation
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unknown whether outcome assessor was blinded

Chen 2006 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	No details of attrition are given
Selective reporting (reporting bias)	Unclear risk	All measures discussed are reported in results. No published protocol to support a judgement
Other bias	Low risk	

das Nair 2012

Methods	<p>Single-site RCT</p> <p>Block randomisation (4 participants) via computer-generated random number sequence generator</p> <p>Group intervention</p> <p>Participants randomised to 1 of 2 intervention groups (Compensation A, Restoration B) or a self-help control group (Self-help C)</p> <p>Outcomes assessed at 3 points: at pre-randomisation (T0), 5 months post-randomisation (T1) and 7 months post-randomisation (T3)</p>
Participants	<p>UK</p> <p>Community</p> <p>Mixed diagnoses group with n = 17 stroke patients (n = 72 whole sample)</p> <p>Method of diagnosis of stroke not specified</p> <p>Memory impairment determined by an overall profile score > 1 on the RBMT. Stroke diagnosis verified by hospital or GP records</p> <p>A: (Compensation) n = 4</p> <p>Mean age: 50.3 (3.30), 3/1 (female/male)</p> <p>Mean time (months) since onset: 73.25 (98.42)</p> <p>B: (Restitution) n = 2</p> <p>Mean age: 43.0 (8.49), 0/2 (female/male)</p> <p>Mean time (months) since onset: 15.50 (0.71)</p> <p>C: n = 11</p> <p>Mean age: 54.8 (10.36), 3/8 (female/male)</p> <p>Mean time (months) since onset: 32.30 (22.99)</p>
Interventions	<p>Manual-based programmes (ensuring consistency of delivery of sessions across time and groups). Comparable format and duration of all 3 programmes</p> <p>2 individual and 10 weekly group sessions. Sessions lasted approximately 1.5 hours, with 10 to 15-minute break. Homework assigned to translate what was learned in sessions to everyday life and practise use of memory aids and relaxation strategies</p> <p>A and B: use of internal memory aids and errorless learning techniques</p> <p>A: use of external memory aids</p> <p>B: exercises to practise encoding and retrieval (including attention retraining exercises, e.g. letter and number cancellation tasks)</p> <p>C: no memory strategies taught; relaxation techniques and ways in which they could cope with their condition</p>

Outcomes	<p>Subjective memory measure: EMQ Objective measure: RBMT - Extended Version Functional ability measure: Nottingham Extended Activities of Daily Living Scale (EADL) Mood measure: General Health Questionnaire-12 (GHQ) Other outcomes assessed: use of memory aids (Internal and External Memory Aids Questionnaires), Emotional state (Wimbledon Self Report Scale), Psychological adjustment (Mental Adjustment to Brain Damage scale)</p>	
Notes	<p>Analysis used in this review: A + B versus C Inclusion criteria: over the age of 18, reported memory problems, diagnosed at least 1 month prior to recruitment, no previous diagnosis of brain damage or other severe disability Exclusion criteria: did not speak English, lived more than 50 miles from Nottingham or Derby Patients were not recruited if they had: uncorrected visual or hearing impairments which prevented them from completing the assessments, no demonstrable memory deficit (defined as overall profile score > 1 on RBMT- Extended version) Adequate matching at baseline - no significant differences at baseline, though larger number of stroke patients in control group Pre-morbid IQ (National Adult Reading Test), language ability (Sheffield Screening Test for Acquired Language Disorders), memory (WAIS-III spatial and digit span, Doors and People), and executive abilities (Trail Making Task, Stroop) were measured at baseline ITT analysis used with LOCF: sensitivity analysis, area under the curve and Mann-Whitney U-tests</p>	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computerised random number generation by independent researcher
Allocation concealment (selection bias)	Low risk	Conducted by independent researcher and allocation was not known by intervention provider after randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and therapists aware of allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors were blind to the random allocation and the intervention participants received. Participants were requested not to disclose any information about intervention at follow-up

Incomplete outcome data (attrition bias) All outcomes	Low risk	List-wise deletion utilised and baseline data were imputed for missing follow-up data
Selective reporting (reporting bias)	Unclear risk	All data discussed were analysed and results disclosed, however protocol not published
Other bias	Low risk	

Doornhein 1998

Methods	<p>RCT Single centre Participants assigned at random to control group (C) or intervention group (I) Outcome assessment done by person who carried out training at end of training No long-term follow-up</p>	
Participants	<p>The Netherlands In-patient (rehabilitation centre) Memory impairment assessed on Dutch version of Rey auditory learning test Method of diagnosing stroke not stated, but all participants recruited from a rehabilitation centre Time since stroke: 3 to 5 months At randomisation (n = 12) I: n = 6; mean age 51.3 years C: n = 6; mean age 51.7 years</p>	
Interventions	<p>I: memory strategy training 2 sessions per week for 4 weeks; subjective memory problems assessed; mnemonic strategies taught were 'association' and 'organisation'. Homework books used C: 'drill and practice' exercises, pay more attention, spend more time repeating material</p>	
Outcomes	<p>Subjective memory measure: Memory Questionnaire Objective memory measure: 15 Words Test Other outcomes assessed: target memory tasks (Name-Face Paired Associated Memory Test, Stylus Maze Test), control memory tasks (Oxford Recurring Faces Test)</p>	
Notes	<p>Patients with severe aphasia, apraxia, or agnosia were excluded Experimental and control groups comparable on important demographic and illness characteristics Number and flow of participants, by intervention group, throughout trial not mentioned Statistics: 2 way-ANOVA, post-hoc Tukey test, ITT analysis not stated, power not stated</p>	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement

Doornhein 1998 (Continued)

Random sequence generation (selection bias)	Unclear risk	“Assigned at random”. No indication of how the random sequence was generated
Allocation concealment (selection bias)	Unclear risk	No information
Blinding of participants and personnel (performance bias) All outcomes	High risk	Both personnel and participants knew allocation, but unclear what effect this may have had on outcome
Blinding of outcome assessment (detection bias) All outcomes	High risk	“testing was not 'blind' and that the evaluation was done by the same person who carried out the training sessions.”
Incomplete outcome data (attrition bias) All outcomes	Low risk	No attrition reported
Selective reporting (reporting bias)	Unclear risk	All data discussed were analysed and results disclosed, however protocol not published
Other bias	Unclear risk	Number and flow of participants, by intervention group, throughout trial not mentioned Statistics: ITT analysis not stated, power not stated

Kaschel 2002

Methods	RCT. A-B-A designed trial consisting of: a 4-week no training baseline (A), 10 weeks of training (B), and a 3-month no training follow-up (A) Multi-centre (7 sites) Participants assigned at random to pragmatic (control) group (C) or imagery (intervention) group (I) Outcomes assessed at 4 time points: pre-baseline, baseline, post-intervention, follow-up at 3 months
Participants	Europe In-patient and out-patient Mixed diagnoses group with n = 7 stroke patients (n = 21 total sample) Stroke diagnosed through CT or MRI scan Memory deficits identified by score of 15 or less on RBMT At randomisation (n = 7, overall mean age: 46.3 years) I: n = 4 Mean age: 51 years 1 LH, 2 RH, 1 bilateral C: n = 3 Mean age: 41.7 years 1 LH, 1 bilateral, 1 brain stem Lost to follow-up: I n = 1

Interventions	<p>Both groups received 10 weeks of training, comprising of 30 individual sessions (70 to 90 minutes)</p> <p>I: imagery training. Patients received 2 training periods: (1) learning the skill of generating images rapidly given verbal information - steps included motivation for imagery training, rapid generation of images of objects and generation and retrieval of images of simple actions; (2) transfer to target problems in everyday life - steps included identification of the problem, identification of the manner in which imagery could help in this situation, simulation of using imagery in this situation (within sessions), transfer of imagery to these kinds of situations (outside sessions)</p> <p>C: pragmatic training. Each participant received individualised treatment including: taught a variety of internal and external strategies, elements of attention training and planning procedures and practical guidelines to encode and retrieve information, according to usual care in their centre</p>
Outcomes	<p>Subjective memory measure: Memory Assessment Clinics rating scale (self)</p> <p>Objective memory measure: RBMT Profile score</p> <p>Other outcomes assessed: (1) Wechsler Memory Scale (total score), RBMT immediate and delayed story recall, 'Appointments' Everyday Memory Test, Memory Assessment Clinics (family) rating scales, d2 subtest</p>
Notes	<p>Inclusion criteria: either in- or out-patients, referred for the rehabilitation of memory problems, age between 20 and 60 years, brain damage documented by CT or MRI scan, at least 6 months following onset, score equal to or less than 15 on the immediate/ delayed story recall test from the RBMT</p> <p>Exclusion criteria: patients with severe memory problems (RBMT scores of 12 points or less), aphasia, neglect, hemianopia, apraxia, agnosia, psychiatric history, substance misuse, affective disorder, or those who cannot generate visual imagery</p> <p>Participating centres had to make sure they could follow up the participants without any break (except holidays) for 7 months, and that they could fulfil the number of training session requirements</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"They were randomly allocated to one or another of the two experimental groups consecutively as the statistician received their data." Method of random sequence generation not specified
Allocation concealment (selection bias)	Low risk	Conducted by statistician
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and therapists aware of allocation

Kaschel 2002 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not stated whether outcome assessor was blind to allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 lost to follow-up
Selective reporting (reporting bias)	Unclear risk	No protocol available to support a judgement
Other bias	Unclear risk	“We did not want to invest a lot of hours with patients who would cease to participate after a few weeks or whose discharge to other wards was planned.” Selection for the study seems highly biased towards participants who were less likely to withdraw

Lannin 2014

Methods	RCT between November 2006 and December 2009 Single site Participants randomised to PDA training group (I) or an attention control group (C) Outcomes assessed at 2 time points, T0 prior to randomisation and T1 8 weeks after randomisation (post-treatment)
Participants	Australia In-patients and out-patients Mixed diagnoses acquired brain injury group with n = 5 stroke participants (n = 42 whole sample) Method of stroke diagnosis not recorded, but all participants were recruited through a rehabilitation centre Memory impairment determined by demonstrating a functional memory impairment (as assessed by the Rivermead Behavioural Memory Test) At randomisation (n = 5): I: n = 3 Mean age: 32 (6), 2/1 (female/male) Mean time since onset: 140 months (73) C: n = 2 Mean age: 29 (10), 0/2 (female/male) Mean time since onset: 16 months (16.6)
Interventions	Both groups received 8 weeks of therapy Median session length 40 minutes I: participants received an “off the shelf” PDA device with features of an alarm, calendar, address book, and camera. Participants prioritised meaningful activities they wanted to increase their independence in or memory of. They received support/training in its use, which consisted of 5 training modules covering selection of an appropriate device, awareness of deficit(s), application skills, and organisational strategies. In addition, training

	<p>incorporated generalisation of strategies outside the therapy and errorless learning. m = 7 hours (\pm 2) therapy time over an average 8 sessions</p> <p>C: participants received 'standard rehabilitation' including the same prioritisation of meaningful activities as I group, and use of non-electronic memory aids (paper diaries, lists, cueing strategies, mnemonics). Individual and group sessions focused on strategies to promote independence. Participants asked not to use electronic devices including alarms. Following the trial participants were given the opportunity to train with the PDA. m = 8 hours (\pm 4) over an average 9 sessions</p>	
Outcomes	<p>Subjective memory measure: Memory Functioning Questionnaire - frequency of forgetting (carer; MFQ)</p> <p>Objective memory measure: RBMT Profile score</p> <p>Additional outcomes assessed: improvement in functional memory goal performance (Goal Attainment Scale), MFQ - severity of forgetting (carer), Memory Compensation Questionnaire (MCQ), Wechsler Test of Adult Reading (WTAR), Controlled Oral Word Association Test (COWAT), Delis-Kaplan Executive Function System Color Word (DKEFS CW), Behavioural Assessment of the Dysexecutive Syndrome (BADs), Full Scale Intelligence Quotient (FSIQ)</p>	
Notes	<p>Inclusion criteria: aged \geq 17 years, diagnosis of acquired brain injury, functional memory impairment (on RBMT), emerged from post-traumatic amnesia, sufficient hand function to use PDA</p> <p>Exclusion criteria not stated</p> <p>MFQ forgetting (carer) scale was used in meta-analysis as this was the only subjective memory data received by the authors for the stroke sub-sample</p> <p>Stroke group had a difference in time since stroke onset but unlikely to have affected outcomes</p> <p>Statistical tests used: t-tests</p>	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Simple randomisation methodology", "Computer generated and stored off-site" Randomisation used a computerised simple randomisation strategy
Allocation concealment (selection bias)	Low risk	"Concealed in opaque, consecutively numbered envelopes by a person not otherwise involved in the study", "a secretary [...] opened these envelopes and read aloud the group allocation"
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and therapists aware of group allocation

Blinding of outcome assessment (detection bias) All outcomes	Low risk	“Assessors were blind to group allocation”, “asked before each assessment not to inform the assessors about their group or interventions received”
Incomplete outcome data (attrition bias) All outcomes	Low risk	No attrition
Selective reporting (reporting bias)	Unclear risk	No protocol published; do not appear to be any methodological differences from earlier conference proceedings available online
Other bias	Low risk	

Lemoncello 2011

Methods	RCT Cross-over design Participants assigned at random (coin flip) to 1 of 2 intervention presentation order groups (A: TAP or B: TYP) Outcomes assessed at 5 time points: pre-randomisation (T0), at 2 weeks (post-first condition, T1), at 4 weeks (post-first cross-over, T2), at 6 weeks (post-second cross-over), at 8 weeks (post-third cross-over, T3) and at 10 weeks (post-final cross-over, T4) Only T1 data used
Participants	USA Community Mixed diagnoses group, with stroke n = 4 (n = 23 whole sample) All participants > 12 months since last stroke Memory impairment determined through self, carer or therapist reported cognitive challenges and a cognitive assessment battery (PASAT, CVLT-II). Method of diagnosing stroke not stated, participants recruited from acquired brain injury (ABI) groups and referrals from speech-language pathologists and ABI specialists At T1 assessment (n = 4): A: TAP n = 3 Mean age: A: 60 (12.17) 3 men B: TYP n = 1 Mean age 62 (9.98) 1 woman
Interventions	Both groups completed 6 tasks; 2 self-selected preferred, 2 self-selected not-preferred, 2 researcher allocated Participants completed 1 condition for 2 weeks, and then alternated to the other condition. This repeated 2 additional times (2 x 2 week on TAP, 2 x 2 week on TAP) A: TAP Television assisted prompting (set top box) that provided reminders at prespecified times for activities personalised to each participant. No prompting by carers/family. Prompts

	varied in frequency but displayed until participant acknowledged or up to 1 hour B: TYP Participants carried out tasks using typical memory methods/strategies. Provided with a list of prospective memory tasks. Carers/family encouraged to remind/motivate	
Outcomes	No outcomes included in analysis Additional outcomes assessed: task completion rates (tracking logs and journal entries) and satisfaction with intervention (qualitative interview)	
Notes	Inclusion criteria: documented diagnosis of ABI > 12 months prior, 18+ years old, reported cognitive challenges limiting completion of home tasks (by patients, carer or therapist), functional vision and hearing to access information on a television Attention (PASAT), Memory (CVLT-2, EMQ) and Executive Functions (BADS) measures were only taken at baseline Statistical tests used: Hierarchical Linear Model (mixed model)	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Participants were randomly assigned to group by the flip of a coin"
Allocation concealment (selection bias)	Unclear risk	Does not state who completed randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and therapists aware of group allocation
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not blinded - researchers also advised of condition switches. "made every effort not to influence participants' report of task completion"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Reasons for loss to follow-up explained for whole (ABI) group, but no details for those with stroke
Selective reporting (reporting bias)	Unclear risk	Gives all outcome measures described in procedure. No published protocol
Other bias	Low risk	

Lin 2014

Methods	RCT between July 2011 and November 2012 Single site Participants assigned at random to an intervention group (I) or control group (C) Outcomes assessed at 2 time points: T0 baseline (at randomisation) and T1 10 weeks post-randomisation (post-intervention)	
Participants	China Outpatients rehabilitation centre Memory impairment determined by z scores ≤ 1.5 on the WMS Memory Quotient. Method of diagnosing stroke not stated, but all participants had MRI scans At randomisation (n = 34): I: n = 16 Mean age: 62.4 (6.0), 6/10 (female/male) Mean time (months) since onset: 7.48 (0.79) 6 LH, 10 RH C: n = 18 Mean age: 63.2 (5.7), 8/10 (female/male) Mean time (months) since onset: 7.50 (0.61) 9 LH, 9 RH	
Interventions	I: 60 hours of training (6 x 1-hour sessions per week for 10 weeks). Computer-assisted executive function and memory training using RehaCom. Training performed by 2 trained psychologists C: received no cognitive training (TAU)	
Outcomes	Objective memory measure: WMS (Memory Quotient total score) Additional outcomes assessed: WMS subtest scores (information, orientation, mental control, logical memory, digits forwards/backwards, visual reproduction, associated learning), TMT-A and TMT-B, fMRI data (functional connectivity)	
Notes	Inclusion criteria: confirmed diagnosis of first stroke, deficits in memory and executive function ($z \leq 1.5$ in WMS Memory Quotient and Trail Making Test), right handed, education ≥ 8 years, 6 to 10 months (180 to 300 days) post-stroke, 45 to 70 years, normal hearing and vision Exclusion criteria: mental retardation, history of Alzheimer's or mental illness (e.g. schizophrenia) prior to stroke, vital organ failure, concomitant antidepressant, psychoactive drug or steroid therapy During fMRI scans participants were excluded if they moved their head > 1.5 mm in any direction or with $> 1.5^\circ$ rotation Study focused on fMRI data Adequate matching at baseline, with no significant differences between clinical and demographic characteristics or baseline neuropsychological test data Statistical tests used: paired t-tests and Chi ² tests	
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement

Lin 2014 (Continued)

Random sequence generation (selection bias)	Low risk	“Random number table”
Allocation concealment (selection bias)	Unclear risk	Random number table not described to have been concealed from study personnel
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants or personnel knew allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	“Assessments were performed by two trained psychologists who were blinded to group assignment”
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts reported, but does not specify how many participants were randomised
Selective reporting (reporting bias)	Unclear risk	No indication of selective reporting, but no published protocol to determine this
Other bias	Low risk	

Prokopenko 2013

Methods	RCT Single site Participants assigned at random via “method of letters” (sealed envelopes) to either an intervention group (I) or a TAU control group (C) Outcomes assessed at 2 time points: T0 baseline (pre-training on day of inclusion) and T1 14 to 16 days after T0 (post training)
Participants	Russia In-patient rehabilitation centre Method of diagnosing memory impairment not stated Stroke diagnosed with NIHSS and routine MRI Recruited 2 weeks post-stroke At randomisation (n = 43) I: n = 24 Median age: 61 (57;69), 11/13 (female/male) C: n = 19 Median age: 66 (61;69), 9/10 (female/male)
Interventions	I: up to 15 hours total (25 to 30 minutes/day for 2 weeks) use of computer programs. (1) Training of attention using computerised Schulte’s tables - provision of on screen feedback (performance speed). (2) Training of visual and spatial gnosis with computer-based “figure-background test” - feedback and gradual decreasing intensity of background noise. (3) Training of visual and spatial memory - remembering the positioning of images with gradually increasing number of distractors. (4) Also “remembering a sequence of

	symbols”, “arranging the clock hands” and “the serial count” C: received only standard treatment at the rehabilitation centre (TAU)
Outcomes	Objective memory measure: MoCA Functional ability measure: IADL scale Mood measure: HADS Quality of life measure: SS-QoL Additional outcomes assessed: dementia severity (MMSE), cognitive disorders (FAB), executive functions (Clock drawing test), attention deficit (Schulte’s tables), satisfaction with the results of treatment (CGIS and PGIS scales)
Notes	Inclusion criteria: cognitive impairments (ranging from mild cognitive impairments to mild dementia) after a hemisphere stroke, no significant speech pathology, no epilepsy, in the acute and early restorative period of stroke Exclusion criteria: did not give informed consent, experienced severe cognitive deficits (MMSE < 20), medically unstable, not fluent in Russian, had another condition that could impact results (e.g. aphasia) Adequate baseline matching of groups, no significant differences on demographic characteristics or neuropsychological tests (based on median data) Statistical tests used: Mann-Whitney U test for between group differences, Wilcoxon Matched Pairs test for within subject differences The study is not included in quantitative analysis as only median results were available, despite contacting authors for mean and SD data

Risk of bias

Bias	Authors’ judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	“Method of letters” (sealed envelopes), “Patients, who were suitable for inclusion criteria, asked to choose one of two identical envelopes, each of envelopes contained a note with number of group inside.” Method of generating random sequence not specified
Allocation concealment (selection bias)	Unclear risk	“Patients, [...], asked to choose one of two identical envelopes” However, not clear how this resulted in unequal group sizes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Both participants and intervention provider knew which group they were allocated to - effects of this on outcomes unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	“Assessments were repeated [...] by a trained assessor blind to randomisation”

Prokopenko 2013 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	No attrition
Selective reporting (reporting bias)	Unclear risk	Data presented in medians and confidence intervals Measures are given in results but not described (SS-QoL)
Other bias	Low risk	

Radford 2012

Methods	RCT Single site Participants assigned using a computerised procedure (“Minim”) stratified by sex, age, estimated full-scale IQ, aetiology, baseline memory (RAVLT Delayed Recall score) Wait-list cross-over trial with participants allocated to an early training group (I) or a late training group (C) Outcomes assessed at 3 time points: T0 baseline, post-randomisation, T1 1 month post early training group’s final session (12 weeks after T0) and T2 1 month post late training group’s final session (24 weeks after T0) T1 data used only
Participants	Australia Community Mixed aetiology study with n = 28 stroke patients (n = 80 whole sample) Method of determining memory impairment not stated. Method of diagnosing stroke not stated, however patients had recently been assessed at a neurology unit, were neurology referrals, or from community stroke support groups At randomisation (n = 28) I: n = 16 Mean age: 53.6 (12.6), 7/9 (female/male) Mean time (months) since onset: 84.1 (148.9) 6 LH, 2 RH, 8 bilateral; 12 infarct, 3 haemorrhage, 1 subarachnoid haemorrhage C: n = 12 Mean age: 46.3 (14.6), 7/5 (female/male) Mean time (months) since onset: 30.7 (26.0) 7 LH, 3 RH, 2 bilateral; 6 infarct, 4 haemorrhage, 2 subarachnoid haemorrhage Lost to follow-up: lost at T1: n = 6 (I: 2 dissatisfied, 2 unable to attend; C: 2 no longer interested/able to attend)
Interventions	Manualised, group-based memory training programme. 6 x 2-hour weekly sessions (including breaks). 9 to 15 participants per group Training in use of compensatory strategies (both internal/mental strategies and external memory aids); education regarding memory function, neurological damage, sleep and lifestyle factors that have an impact on memory. Homework tasks set to encourage practice and generalisation of strategy use between sessions I: received memory training immediately after randomisation (early training), followed

	<p>by T1 post-training assessment and cross-over. The group then received no training for 6 weeks, followed by T2 follow-up assessment</p> <p>C: received no memory training immediately after randomisation, followed by T1 pre-training assessment and cross-over. The group then received memory training (late training) followed by T2 post-trial training assessment</p>
Outcomes	<p>Subjective memory measure: Comprehensive Assessment of Prospective Memory (CAPM-Self)</p> <p>Objective memory measure: RAVLT Delayed Recall</p> <p>Additional outcomes assessed: CAPM-Other (report of a relative or friend), estimate of self-awareness of memory function (absolute discrepancy between scores from the CAPM-self and CAPM-other), RAVLT Total Learning score, prospective memory function (Royal Prince Alfred Prospective Memory Test; RPA-ProMem), self-reported memory strategy use (number and type of strategies used)</p>
Notes	<p>Only pre-cross-over data included in this analysis (T1)</p> <p>Inclusion criteria: memory complaints, English as language of choice, proximity to the hospital, age between 18 and 70, estimated Full Scale IQ \geq 80</p> <p>Exclusion criteria: history of psychiatric (other than a mood) disorder, progressive lesions</p> <p>Compliance: participants had to attend at least 4 of 6 training sessions to be retained in the study</p> <p>Mood was measured at baseline only on the Depression Anxiety Stress Scale (DASS-21) - short form</p> <p>Adequacy of matching at baseline unclear as stroke sub-sample data at baseline are not presented. Likely to be well matched due to stratification of randomisation procedure</p> <p>Statistical tests used: one-way ANOVA and Chi² tests on baseline data, repeated measures (3 x 2) ANOVA, reliable change indices, Wilcoxon signed-rank tests for pre-post training changes</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Stratified randomisation procedure using software program which allowed predetermined variables relevant for group matching to be entered into a database for each participant. Allocations generated by factoring in previous allocations and balancing predetermined variables across groups
Allocation concealment (selection bias)	Low risk	Centralised randomisation using a computerised system
Blinding of participants and personnel (performance bias) All outcomes	High risk	Therapists and participants aware of group allocation

Radford 2012 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	High risk	Lack of blinding to treatment allocation for assessment. Same clinicians were involved in conduct of training groups and outcome assessment
Incomplete outcome data (attrition bias) All outcomes	Low risk	Reasons for attrition in stroke group not specified in published data, but authors did provide additional information
Selective reporting (reporting bias)	Unclear risk	No published protocol available to enable a judgement
Other bias	Low risk	

Westerberg 2007

Methods	RCT (pilot study) Single site Participants assigned to conditions using sealed, pre-addressed envelopes (prepared by persons unrelated to study) opened after the initial assessment Allocation to either a treatment group (I) or a passive control group (C) Outcomes assessed at 2 points: T0 pre-treatment (baseline) and T1 after 5 weeks post-baseline
Participants	Sweden Community Method of diagnosing memory difficulties not stated Stroke diagnosed through PET, MRI or CT scan At randomisation n = 21, at T1 n = 19: I: n = 9 Mean age: 55 (8), 1/8 (female/male) Mean time (months) since onset: 19.3 (6.2) 4 LH, 2 RH, 8 bilateral; 6 haemorrhages, 3 infarctions C: n = 9 Mean age: 53.6 (8), 5/4 (female/male) Mean time (months) since onset: 20.8 (6.2) 3 LH, 4 RH; 2 haemorrhages, 7 infarctions Lost to follow-up: n = 3 (I: 1 computer problems, 1 depression and changed medication; C: 1 epilepsy debut)
Interventions	I: computerized training on battery of visuospatial and auditory WM tasks 90 trials (40 minutes) x 5 days per week for 5 weeks. Participants given a CD with training software (RoboMemo, Cogmed Cognitive Medical Systems, Sweden) and asked to complete 5 weeks of WM training at home on a PC. All training tasks involved: (1) maintenance of multiple stimuli at same time; (2) short delays during which the representation of stimuli should be held in WM; (3) unique sequencing of stimuli order in each trail; (4) the difficulty level adapting as a function of individual performance Participants reported daily results via the Internet to a server at the hospital

	C: no training provided. Did not receive telephone calls during the 5 weeks between test and retest
Outcomes	<p>Subjective memory measure: Cognitive Failures Questionnaire (CFQ) - modified</p> <p>Objective memory measure: Claeson-Dahl word list - delayed recall</p> <p>Additional outcomes assessed: neuropsychological test battery including digit span (WAIS-R; auditory WM), span board (WAIS-R NI; visuospatial WM), PASAT version A (WM and attention control), Ruff 2 and 7 - serial cancellation test (WM and attention control), Claeson-Dahl word list recall test (learning and declarative memory), Stroop test (interference control), Raven's progressive matrices - modified (non-verbal reasoning and problem-solving ability)</p>
Notes	<p>Inclusion criteria: suffering stroke between 12 and 36 months ago, stroke documented by PET, MR or CT, ages 30 to 65, having daily access to a PC with Internet connection at home, self-reported deficits in attention</p> <p>Exclusion criteria: IQ < 70 (based on age-normalised results from WAIS-R), motor or perceptual handicap that would prevent use of computer program, changing medication during study period, fulfilling criteria for major depressive disorder diagnosis (DSM-IV), known history of abuse of alcohol or illicit drugs</p> <p>Compliance: criterion for sufficient compliance was defined before the study as more than 20 days of training (m = 23 training days (SD 2.2))</p> <p>Adequate matching at baseline as there does not appear to be any significant differences between groups. Only a slight greater proportion of men in control group (but small sample size so difficult to determine if this may have had an effect)</p> <p>Statistical tests used: ANCOVA with baseline score as a covariate and effect sizes</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Use of sealed, pre-addressed envelopes, however method regarding preparation sealed envelopes was not specified
Allocation concealment (selection bias)	Low risk	Allocation was not known by intervention provider until envelopes were opened (after baseline assessment)
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and therapists aware of allocation
Blinding of outcome assessment (detection bias) All outcomes	High risk	Post-randomisation, test administrators were no longer blind to allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	3 lost to follow-up

Selective reporting (reporting bias)	Unclear risk	No published protocol available to enable a judgement
Other bias	Low risk	

Zucchella 2014

Methods	RCT between 1 June 2010 and 31 December 2012 Single site Participants assigned to either an intervention group (I) or an attention control group (C) Outcomes assessed at 2 time points: T0 baseline, within 2 weeks of admission to a neurorehabilitation unit, and T1 at 4 weeks, directly after intervention
Participants	Italy In-patient rehabilitation unit Method of diagnosing memory problems from scores below population norms on 3+ neuropsychological tests Stroke diagnosis confirmed through neuroimaging (CT or MRI) Mean time (months) since onset for all participants was less than 4 weeks At randomisation n = 92, demographic details provided at T1 n = 87: I: n = 42 Mean age: 66.6 (13.2), 19/23 (female/male) 12 LH, 18 RH, 1 bilateral; 8 brain stem, 3 cerebellum, 31 ischaemic, 11 haemorrhagic C: n = 45 Mean age: 69.4 (11), 22/23 (female/male) 14 LH, 27 RH, 1 bilateral; 3 brain stem, 34 ischaemic, 11 haemorrhagic Lost to follow-up: n = 5 (I: 3 (1 poor compliance, 2 worsening of clinical condition); C: 2 (poor clinical condition so no T1 follow-up))
Interventions	I: 16 hours (1 hour x 4/week for 4 weeks). 45 minutes therapist-guided computer exercises using 2 software programs (“una palestra per la menta”, “Training di riabilitazione cognitiva”) on time orientation, spatial orientation, visual attention, logical reasoning, memory, executive function. Exercises increased in difficulty when 70% correct. Given metacognitive strategies to improve awareness and self-regulation. 15 minutes to discuss problems, how to transfer strategies to everyday, and imagination to improve memory C: 16 hours with a psychologist discussing general topics, news and their recent activities
Outcomes	Objective memory measure: RAVLT delayed recall Functional ability measure: Functional Independence Measure Additional outcomes assessed: MMSE, digit span, Corsi’s test, RAVLT immediate recall, logical memory (WMS), Progressive Matrices 47 (PM47), Frontal Assessment Battery (FAB), TMT-A/B, Attentive matrices, phonological and semantic fluency, Rey-Osterrieth Complex Figure copy
Notes	Inclusion criteria: first ever ischaemic/haemorrhagic stroke (confirmed by neuroimaging), acute event within 4 weeks, 45 to 80 years, MMSE > 10, below population norm on 3+ neuropsychological tests

Exclusion criteria: progressing stroke, neglect, aphasia, additional neurological/psychological disorder, HDRS score > 7, premorbid IQ < 70/pre-existing dementia, visual deficits, motor impairment

Groups were adequately matched at baseline: no significant differences on socio-demographic, clinical, and functional aspects, or on neuropsychological tests

Statistical tests used: all data were presented as medians and upper/lower quartiles, and data were not normally distributed. Mann-Whitney U test and the Chi² test for demographic and baseline data. Wilcoxon signed-rank tests for within group analysis. Mann-Whitney U tests for between-group outcome analysis

Authors were contacted for means and SDs of measures

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomly assigned [...] by means of a computer random number generator"
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and therapist aware of group allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Assessments done by a psychologist blind to the patients' randomisation and not involved in their care"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Similar numbers of attrition for both arms with similar reasons "worsening of clinical condition"
Selective reporting (reporting bias)	Unclear risk	No published protocol
Other bias	Low risk	

ABI: acquired brain injury; (R)AVLT: Rey Auditory Verbal Learning Test; C: control; CBT: cognitive behavioural therapy; CES-D: Center for Epidemiological Studies Depression Scale; CGIS: Clinical Global Impressions - Severity; CT: computerised tomography; DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, 4th Edition; EMQ: Everyday Memory Questionnaire; EQ-5D: EuroQol five dimensions; fMRI: functional magnetic resonance imaging; GP: general practitioner; HADS: Hospital Anxiety and Depression Scale; HDRS: Hamilton Depression Rating Scale; I: intervention; IADL: Instrumental Activities of Daily Living; ITT: intention-to-treat; LH: left hemisphere; LOCF: last observation carried forward; MMSE: Mini-Mental State Examination; MSE: Memory Self Efficacy; MoCa: Montreal Cognitive Assessment; MRI: magnetic resonance imaging; MS: multiple sclerosis; NIHSS: National Institute of Health Stroke Scale; PASAT: Paced Auditory Serial Addition Test; PDA: personal digital assistant; PET: positron emission tomography; PGIS: Patient Global Impressions - Severity; RBMT: Rivermead Behavioural Memory Test; RCT: randomised controlled trial; RH: right hemisphere; SD: standard deviation; SS-QoL: Stroke Specific Quality of Life Scale; TAU: treatment as usual; TMT: Trail Making Test; VAS: visual analogue scale; WAIS: Wechsler Adult Intelligence Scale; WM: working memory; WMS: Wechsler Memory Scale

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Barker-Collo 2009	Not memory - rehabilitation focused on attention difficulties
Blanchet 2016	Not memory - rehabilitation focused on aerobic exercises and attention training
Brainin 2015	Not cognitive rehabilitation - intervention specifies “Intensive control and motivation for better compliance with medication, regular blood pressure measurements, diet changes and physical activity”, no cognitive component to intervention
Bushnick 2010	Not memory - rehabilitation focused on executive functioning
Chen 2011	Not memory - rehabilitation focused on attention and executive control
Chen 2015	Not memory - rehabilitation focused on attention
de Joode 2013	Not stroke - mixed aetiology study with no separate data available for those with stroke. Could not obtain separate stroke data - none provided in published study or via authors
de Luca 2014	Not stroke - mixed aetiology study and could not obtain separate stroke data - none provided in published study or via authors
Evans 2000	Not cognitive rehabilitation (2007 review)
Fish 2008	Not RCT - study used same randomisation procedure as Wilson 2001
Fong 2009	Not RCT - matched pairs design, not randomly allocated
Gamito 2014	Not cognitive rehabilitation - both intervention groups received the same rehabilitation through different method (either on screen or through a headset)
Gasparrini 1979	Not RCT (2007 review) - alternate allocation, not random, poor concealment, allocation, treatment, and outcomes all completed by same person
Hildebrandt 2006	Not RCT - no indication of method of randomisation, allocated according to age and scores on tests
Imes 1984	Review paper (2007 review)
Klonoff 2007	Not RCT - no allocation to groups
Liu 2009	Not memory - focus on mental imagery for motor function
Lundqvist 2010	Not stroke - mixed aetiology group and could not obtain separate stroke data - none provided in published study or via authors

(Continued)

Man 2006	Not memory - skill training focused on problem solving
Markle-Reid 2011	Not cognitive rehabilitation - the “specialised, evidence-based rehabilitation strategy” did not involve cognitive rehabilitation
McDonald 2011	Not stroke - mixed aetiology study and could not obtain separate stroke data - none provided in published study or via authors
McEwan 2014	Not memory - CO-OP training does not cover aspects of memory
McEwen 2015	Not memory - study used same CO-OP training as previous excluded McEwan 2014 study
Miller 2014	Not RCT - pseudo-random allocation with final 16 enrolled participants allocated on demographic variables
Owensworth 1999	Not stroke - mixed aetiology study and data not available for the 1 stroke patient
Polatajko 2012	Not memory - study used CO-OP training
Rasmussen 2016	Not cognitive rehabilitation - home-based rehabilitation did not involve any cognitive rehabilitation
Schupp 2002	Not memory - rehabilitation focused on attention. Only able to find study poster in conference proceedings
Skidmore 2015	Not memory - intervention targets executive functioning
Sohlberg 2007	Not RCT - no randomisation, all participants received the same intervention
Tailby 2003	Not RCT - no randomisation. “Participants were divided into three groups, with eight in each, on the basis of their performance on the Verbal Memory Index (VMI) on the Wechsler Memory Scale-III”
Thickpenny-Davis 2007	Not RCT - non-random allocation, every second participant allocated to wait-list control
Thoene 1995	Not stroke - no stroke participants in brain injury sample
Wilson 2001	Not RCT (2007 review) - alternate allocation of blocks to treatment or waiting list
Wolf 2015	Not memory - study used CO-OP training
Yu 2009	Not cognitive rehabilitation - community-based rehabilitation

CO-OP: Cognitive Orientation to daily Occupational Performance; RCT: randomised controlled trial

Characteristics of studies awaiting assessment *[ordered by study ID]*

Bezdenzhnykh 2014

Methods	RCT Single site Participants assigned to either an intervention (I) or TAU control group (C) Outcomes assessed at 3 time points: T0 baseline (10 to 12 days post-stroke), T1 post-intervention (18 to 20 days after randomisation) and T2 6 to 8 months post-intervention
Participants	100 hemispheric stroke (acute) participants with cognitive impairments Age range: 45 to 65 years
Interventions	I: TAU plus 10 to 14 daily training sessions with neuropsychological computer program for 40 minutes per day for 2 weeks C: TAU with no special cognitive correction
Outcomes	Objective memory measure: FAB Additional outcomes assessed: MMSE, CDT, speech tests (cognitive, neurological, affective, and functional states assessed)
Notes	Authors have not yet been contacted to obtain published results outside of this conference abstract

Bezdenzhnykh 2015

Methods	RCT Single site Participants were allocated to 1 of 3 groups: an intervention (I), an active control (C1), or a TAU control (C2) Outcomes assessed at 2 time points: T0 baseline (before training) and T1 post training
Participants	55 participants with post-stroke (acute) vascular cognitive impairments Age range: 37 to 67 years
Interventions	I: 10 daily (40 minute) sessions with neuropsychological computer programs C1: entertaining games keeping the identical regimen C2: TAU
Outcomes	Objective memory measure: FAB Functional ability measure: IADL Additional outcomes assessed: MMSE, MoCA, CDT, Shulte's test
Notes	Authors have not yet been contacted to obtain published results outside of this conference abstract

Matz 2007

Methods	RCT Single site Participants assigned to either treatment group (I) or treatment as usual control group (C) Outcomes assessed at 2 time points: T0 baseline and T1 after 3 months of rehabilitation
Participants	32 participants with lacunar stroke
Interventions	I: regular cognitive training sessions for 3 months guided by neuropsychologist C: standard care without cognitive training
Outcomes	Objective memory measure: memory test from neuropsychological test battery Other outcomes assessed: neuropsychological test battery (speed of cognitive processing, executive functions, attention, visuo-spatial function), lipid values (total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides), 24-hour blood pressure recording, brain imaging with MRT
Notes	Authors have not yet been contacted to obtain published results outside of this conference abstract

Prokopenko 2011

Methods	Single site Participants allocated to either an intervention group (I) or a TAU control group (C)
Participants	100 post-stroke (acute) participants with mild cognitive impairment to mild dementia
Interventions	I: TAU with computer programs 20 to 30 minutes per day 5 x per week over 14 days C: TAU
Outcomes	Objective memory measures: FAB Additional outcomes assessed: MMSE, CDT, Shulte's tables, and a letter correction test
Notes	Authors have not yet been contacted to obtain published results outside of this conference abstract Not stated whether allocation was randomised

CDT: Clock Drawing Test; FAB: Frontal Assessment Battery; HDL: high-density lipoprotein; IADL: Instrumental Activities of Daily Living; LDL: low-density lipoprotein; MMSE: Mini-Mental State Examination; MoCA: Montreal Cognitive Assessment; MRT: magnetic resonance tomography; RCT: randomised controlled trial; TAU: treatment as usual

Characteristics of ongoing studies [ordered by study ID]

ISRCTN45171788

Trial name or title	Neuropsychological rehabilitation: modular cognitive retraining versus compensatory skills training
Methods	RCT
Participants	Severe head trauma and stroke patients at a neuropsychological inpatient centre
Interventions	Compensatory skills training (memory skills) versus retraining basic cognitive impairments control (problem solving) 5 weeks of intervention
Outcomes	Not stated
Starting date	1 April 2002
Contact information	Dr Peter Frommelt, Asklepios Klinik Schaufling, p.frommelt@asklepios.com
Notes	Overall trial status reported as completed, no study results available (authors contacted)

ISRCTN59754564

Trial name or title	Investigating the effects of cognitive training on attention
Methods	RCT Outcomes assessed at T1, 4 weeks post baseline and T2, 3 months post baseline
Participants	Stroke patients. Planned sample size n = 100
Interventions	2 intervention conditions: home-based online working memory training or a similar training programme focused on attention skills. 20 minutes/day, 5 times/week over 4 weeks (20 sessions total) 1 control condition: waiting list control group
Outcomes	A range of cognitive tasks and questionnaires about everyday function
Starting date	November 2014
Contact information	Dr Polly Peers, MRC Cognition and Brain Sciences Unit, polly.peers@mrc-cbu.cam.ac.uk
Notes	Still recruiting participants

NCT01674790

Trial name or title	Combined effects of aerobic exercise and cognitive training on cognition after stroke
Methods	RCT Factorial assignment Outcomes assessed at baseline, T0 and at 10 weeks T1

NCT01674790 (Continued)

Participants	Stroke patients. Estimated enrolment n = 20
Interventions	A: Aerobic Group - 12 sessions (20 minutes x 2 x 5 days/week for 6 weeks) of aerobic training and range of motion exercise B: 12 sessions (20 minutes x 2 x 5 days/week for 6 weeks) of cognitive training and range of motion exercise A+B: 12 sessions (20 minutes x 2 x 5 days/week for 6 weeks) of aerobic training and cognitive training C: Control - 12 sessions (20 minutes x 2 x 5 days/week for 6 weeks) of range of motion exercise and unstructured mental activity
Outcomes	Subjective memory measure: Cognitive Failures Questionnaire Objective memory measure: Sternberg digit memory task Additional outcomes assessed: Flanker Test, Raven's matrices test, peak oxygen consumption, Fatigue Severity Scale, Montreal Cognitive Assessment, Expression of BDNF and IGF-1 in peripheral blood samples
Starting date	September 2012
Contact information	Marilyn MacKay-Lyons, 9024942632, m.mackay-lyons@dal.ca
Notes	Still recruiting participants

NCT02384057

Trial name or title	Cognitive rehabilitation with C8 Sciences
Methods	RCT, single-blind Outcomes assessed at T0 baseline, T1, 34 days from baseline and T2, 64 days from baseline
Participants	Stroke and brain injury patients. Estimated enrolment n = 64
Interventions	Intervention: C8 sciences cognitive rehabilitation with C8 sciences, computerised cognitive training program (1000 minutes) Control: conventional cognitive rehabilitation
Outcomes	Subjective memory measure: subjective memory complaint questionnaire Objective memory measure: CANTAB Functional abilities measure: Korean Instrumental Activities of Daily Living (K-IADL) Mood measure: Beck Depression Index QoL measure: Stroke Impact Scale Additional outcomes assessed: mood (Geriatric Depression Scale), cognitive abilities (Korean MMSE; K-MMSE), activities of daily living (Korean Activities of Daily Living; K-ADL), clinical dementia rating scale (CDR), Stroke Impact Scale, NIH toolbox, autobiographical memory, Trail Making Test (TMT-A/B and TMT Black and White)
Starting date	December 2014
Contact information	Joon-Ho Shin, MS, National Rehabilitation Center, Seoul, Korea, asfreelyas@gmail.com

NCT02384057 (Continued)

Notes	Study is currently recruiting participants
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NCT02482688

Trial name or title	A randomised controlled study of early versus late, and unisensory versus multisensory rehabilitation for stroke patients with perceptual and cognitive impairments
Methods	RCT, single-blind Outcomes assessed at T1, 1 month post randomisation and T2, 6 month post randomisation
Participants	Stroke patients, estimated enrolment n = 80
Interventions	2 intervention conditions: Multisensory Acute (multisensory intervention delivered within 2 months post-stroke) and Multisensory Chronic (multisensory intervention delivered 6 months post-stroke) 2 control conditions (active comparators): Unisensory Acute (unisensory intervention delivered within 2 months post-stroke) and Unisensory Chronic (unisensory intervention delivered 6 months post-stroke)
Outcomes	Functional abilities measure: Nottingham Extended ADL (EADL) Quality of life measures: unspecified quality of life measure Additional outcomes assessed: Birmingham Cognitive Screen (BCoS), Oxford Cognitive Screen (OCS), functional outcome (Stroke Impact Scale - SIS), fMRI data
Starting date	April 2015
Contact information	Ayla Barutcu PhD, University of Oxford, ayla.barutcu@psy.ox.ac.uk
Notes	Study is currently recruiting participants

Sahakian 2016

Trial name or title	Investigation into the efficacy of cognitive training on cognition in adults with brain injury
Methods	Insufficient information
Participants	Adults with brain injury (traumatic injury, stroke or brain tumour), estimated enrolment n = 50
Interventions	12 hours of cognitive training on a Neurogame
Outcomes	Cognitive function, brain injury-related symptomatology, health, mood, impulsivity, and well-being
Starting date	December 2014
Contact information	Prof Barbara Sahakian, bjs-sec@medschl.cam.ac.uk

Sahakian 2016 (Continued)

Notes	Not stated whether the trial is randomised, still recruiting
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Yang 2014

Trial name or title	The synergistic effect of acupuncture and computer-based cognitive training on post-stroke cognitive dysfunction: a study protocol for a randomised controlled trial of 2 × 2 factorial design
Methods	RCT, 2 × 2 factorial design Outcomes assessed at T1, 4 weeks post baseline, T2, 8 weeks, and T3, 12 weeks
Participants	Stroke patients, estimated enrolment n = 240
Interventions	3 intervention groups: RehaCom, acupuncture, or combination RehaCom and acupuncture. 12-week intervention, 30 minutes/day 5 days/week 1 control group: treatment as usual
Outcomes	Functional abilities measure: FIM Additional outcomes assessed: Montreal Cognitive Assessment (MoCa), MMSE, fMRI data
Starting date	January 2012
Contact information	Lidian Chen, Fujian University of Traditional Chinese Medicine, lidianchen87@163.com
Notes	Study has finished recruiting participants, no response from author for request for findings

CANTAB: Cambridge Neuropsychological Test Automated Battery; EADL: extended activities of daily living; FIM: Functional Independence Measure; fMRI: functional magnetic resonance imaging; GHQ: General Health Questionnaire; NIH: National Institutes of Health; RBMT-E: Rivermead Behavioural Memory Test - extended version; MMSE: Mini-Mental State Examination; NIHSS: National Institute of Health Stroke Subscale; RCT: randomised controlled trial

DATA AND ANALYSES

Comparison 1. Memory training versus no memory training

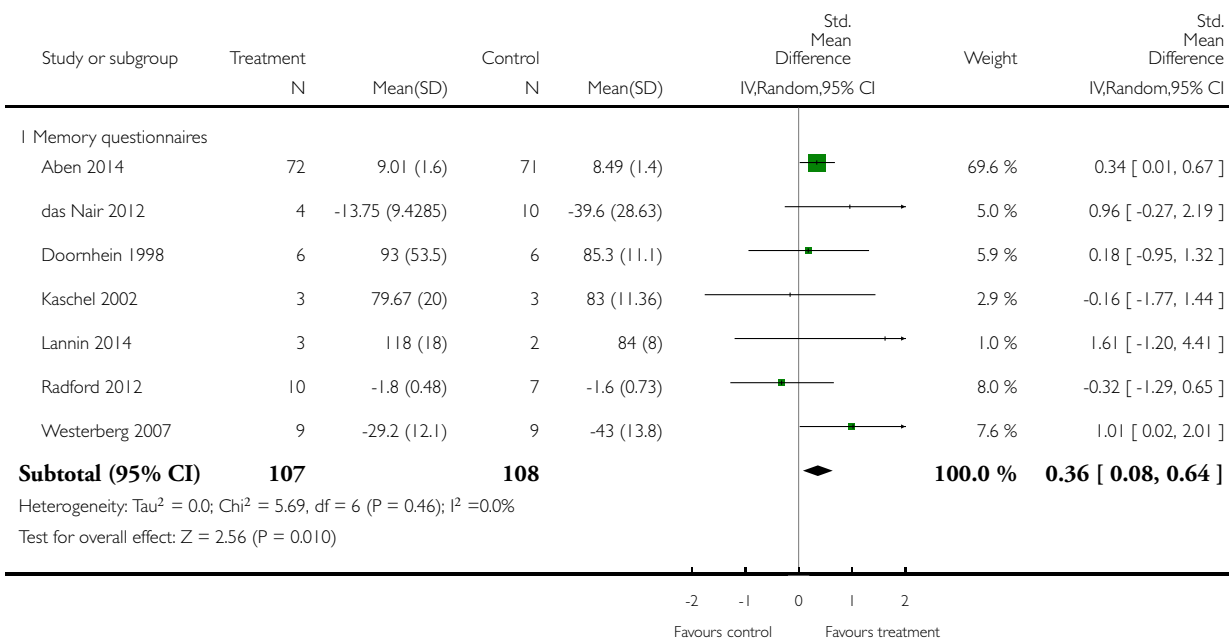
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Subjective memory measures (immediate outcome)	7		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
1.1 Memory questionnaires	7	215	Std. Mean Difference (IV, Random, 95% CI)	0.36 [0.08, 0.64]
2 Subjective memory measures (long-term outcome)	3		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
2.1 Memory questionnaires	3	149	Std. Mean Difference (IV, Random, 95% CI)	0.31 [-0.02, 0.64]
3 Objective memory measures (immediate outcome)	10		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
3.1 Comprehensive batteries	5	91	Std. Mean Difference (IV, Random, 95% CI)	0.25 [-0.36, 0.86]
3.2 Verbal memory sub-tests	5	266	Std. Mean Difference (IV, Random, 95% CI)	0.21 [-0.03, 0.46]
4 Objective memory measures (long-term outcome)	3		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
4.1 Comprehensive batteries	3	49	Std. Mean Difference (IV, Random, 95% CI)	-0.17 [-0.74, 0.41]
5 Functional ability measures (immediate outcome)	3		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
5.1 Functional ability measures	3	164	Std. Mean Difference (IV, Random, 95% CI)	1.17 [-0.35, 2.68]
6 Mood measures (immediate outcome)	3		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
6.1 Mood measures	3	194	Std. Mean Difference (IV, Random, 95% CI)	-0.07 [-0.35, 0.21]
7 Mood measures (long-term outcome)	3		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
7.1 Mood measures	3	175	Std. Mean Difference (IV, Random, 95% CI)	-0.17 [-0.54, 0.19]

Analysis 1.1. Comparison 1 Memory training versus no memory training, Outcome 1 Subjective memory measures (immediate outcome).

Review: Cognitive rehabilitation for memory deficits after stroke

Comparison: 1 Memory training versus no memory training

Outcome: 1 Subjective memory measures (immediate outcome)

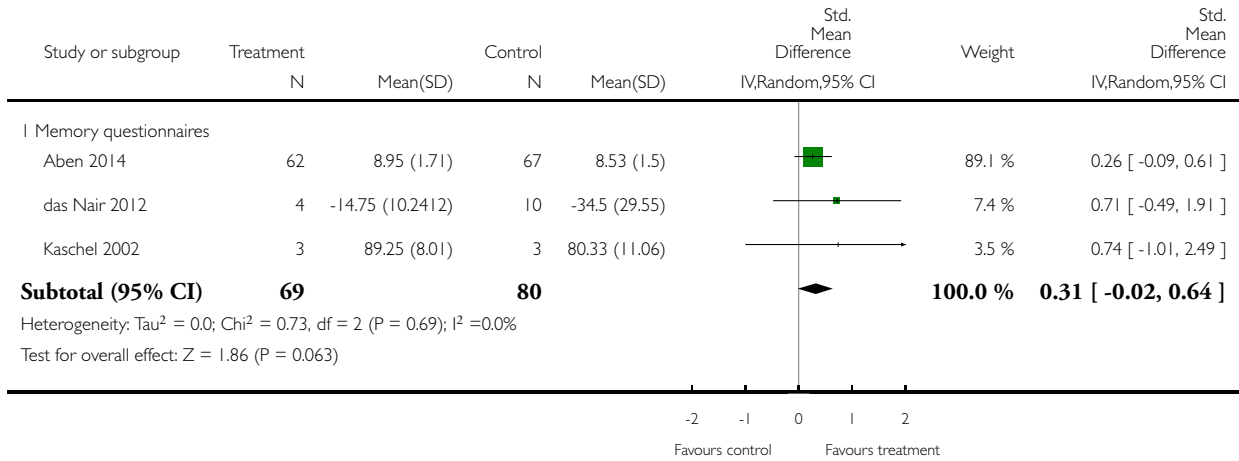


Analysis 1.2. Comparison 1 Memory training versus no memory training, Outcome 2 Subjective memory measures (long-term outcome).

Review: Cognitive rehabilitation for memory deficits after stroke

Comparison: 1 Memory training versus no memory training

Outcome: 2 Subjective memory measures (long-term outcome)

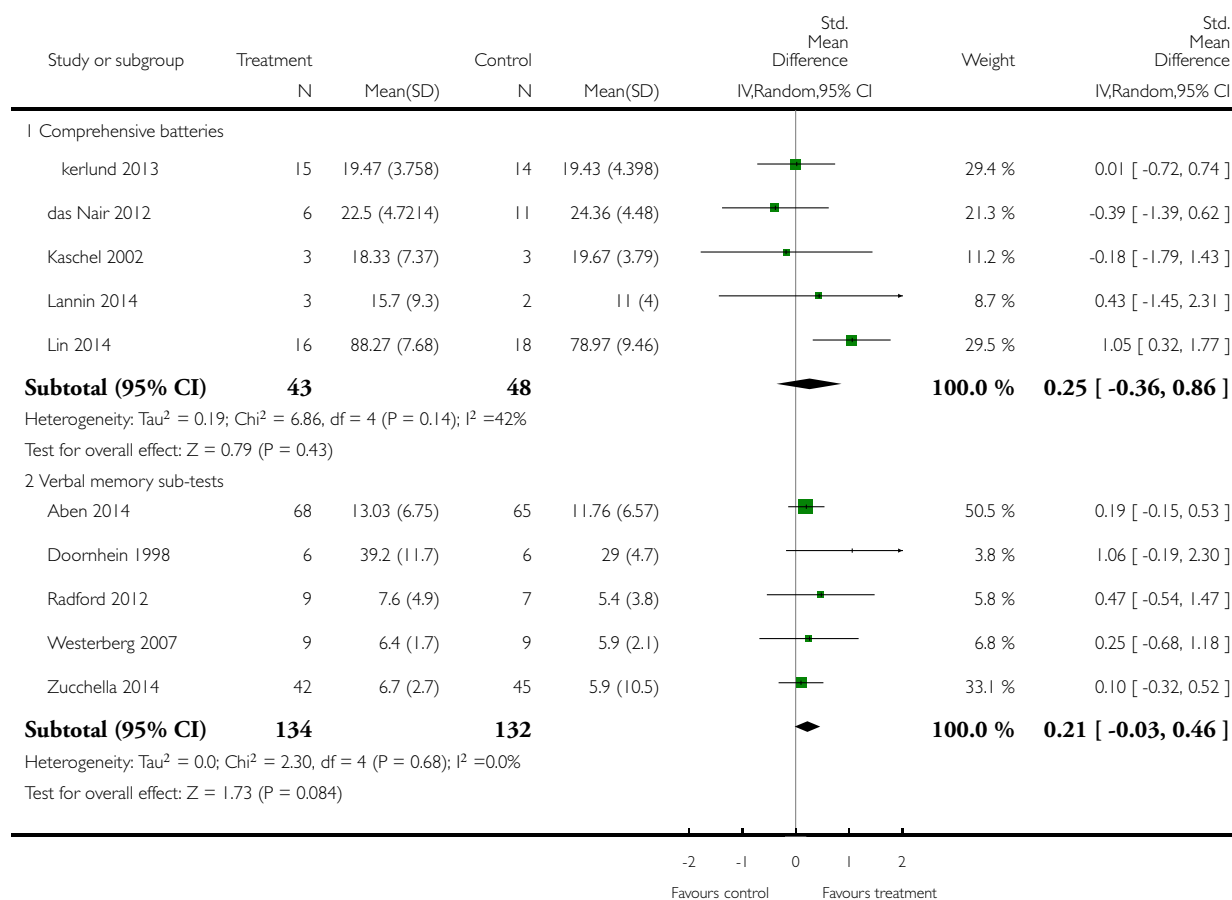


Analysis 1.3. Comparison 1 Memory training versus no memory training, Outcome 3 Objective memory measures (immediate outcome).

Review: Cognitive rehabilitation for memory deficits after stroke

Comparison: 1 Memory training versus no memory training

Outcome: 3 Objective memory measures (immediate outcome)

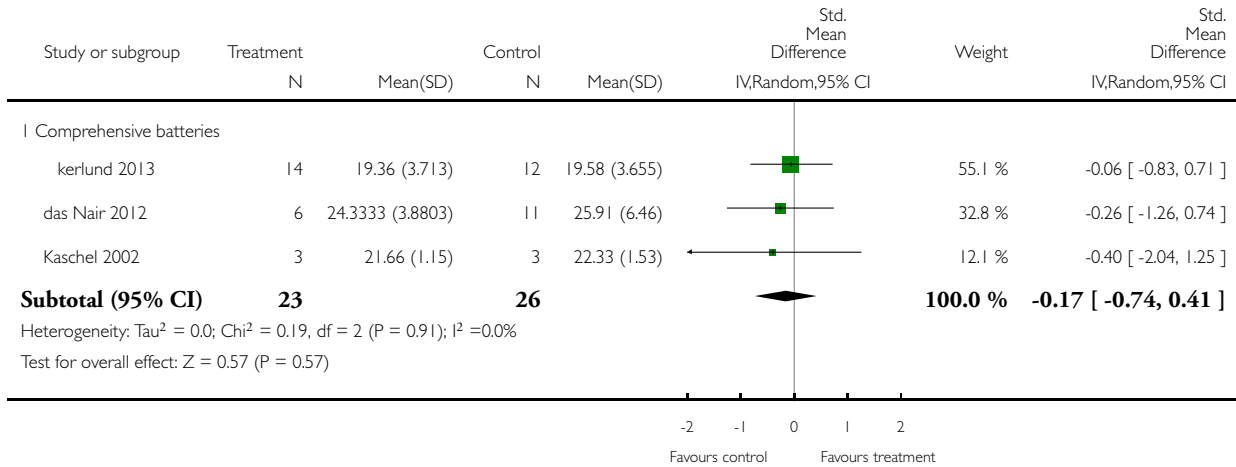


Analysis 1.4. Comparison 1 Memory training versus no memory training, Outcome 4 Objective memory measures (long-term outcome).

Review: Cognitive rehabilitation for memory deficits after stroke

Comparison: 1 Memory training versus no memory training

Outcome: 4 Objective memory measures (long-term outcome)

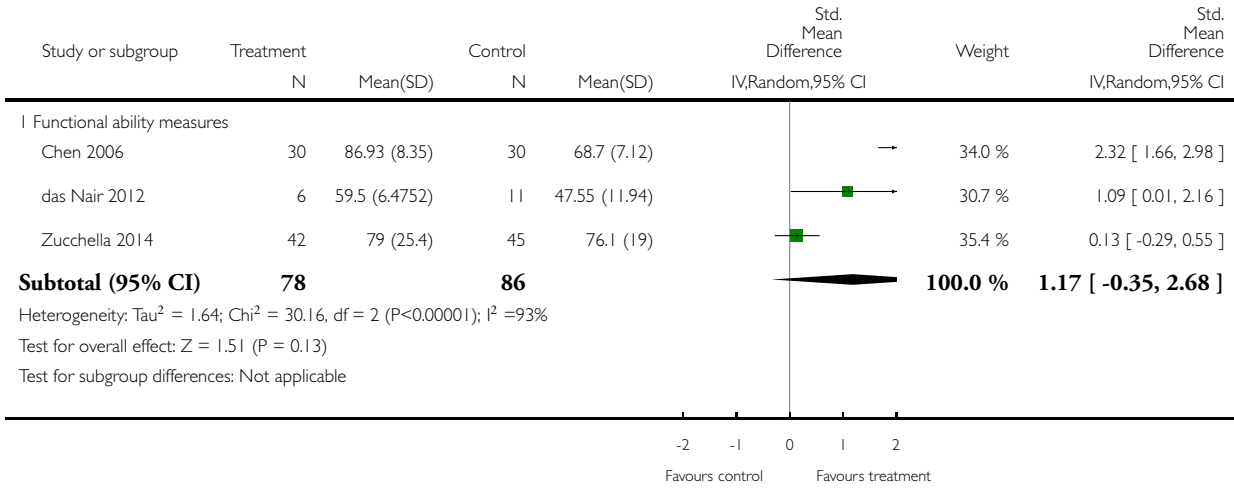


Analysis 1.5. Comparison 1 Memory training versus no memory training, Outcome 5 Functional ability measures (immediate outcome).

Review: Cognitive rehabilitation for memory deficits after stroke

Comparison: 1 Memory training versus no memory training

Outcome: 5 Functional ability measures (immediate outcome)

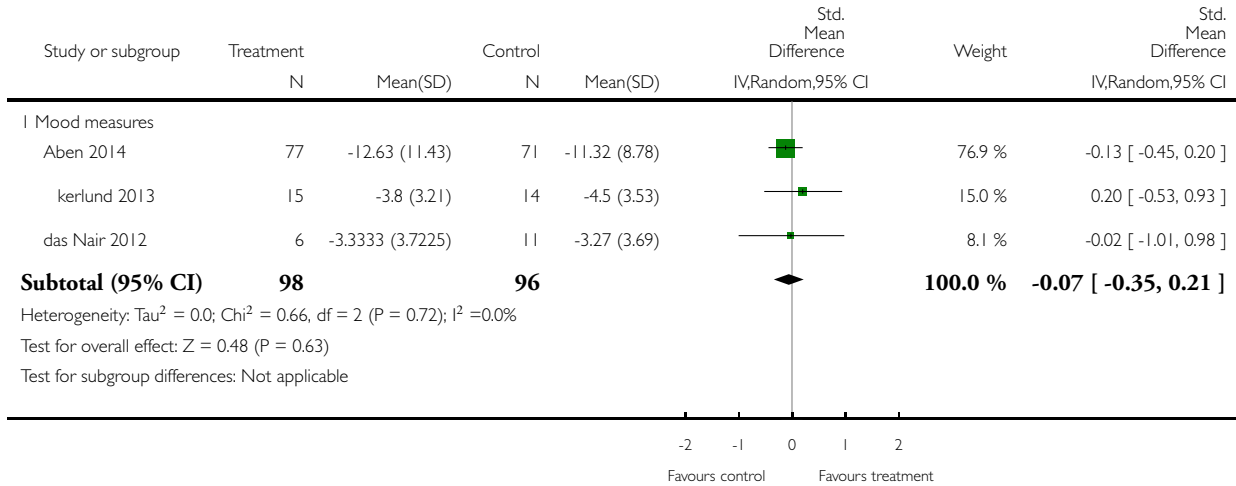


Analysis 1.6. Comparison 1 Memory training versus no memory training, Outcome 6 Mood measures (immediate outcome).

Review: Cognitive rehabilitation for memory deficits after stroke

Comparison: 1 Memory training versus no memory training

Outcome: 6 Mood measures (immediate outcome)

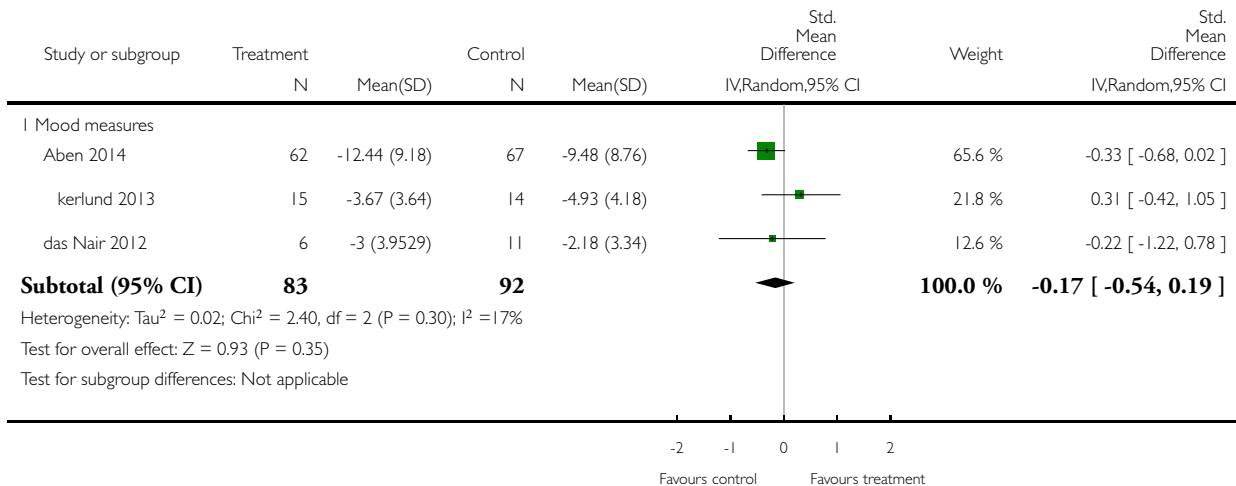


Analysis 1.7. Comparison 1 Memory training versus no memory training, Outcome 7 Mood measures (long-term outcome).

Review: Cognitive rehabilitation for memory deficits after stroke

Comparison: 1 Memory training versus no memory training

Outcome: 7 Mood measures (long-term outcome)



APPENDICES

Appendix I. Cochrane Central Register of Controlled Trials (CENTRAL) search strategy

#1 MeSH descriptor: [Cerebrovascular Disorders] explode all trees

#2 (stroke\$ or cerebrovascular\$ or cerebral vascular or CVA\$):ti,ab,kw (Word variations have been searched)

#3 #1 or #2

#4 MeSH descriptor: [Attention] explode all trees

#5 MeSH descriptor: [Cognition] explode all trees

#6 MeSH descriptor: [Memory] explode all trees

#7 MeSH descriptor: [Cognition Disorders] explode all trees

#8 MeSH descriptor: [Memory Disorders] explode all trees

#9 (cognitive or cognition or attention\$ or memory or concentration or distract\$ or alert\$):ti,ab,kw (Word variations have been searched)

#10 {or #4-#9}

#11 (training or re-training or retraining or therap\$ or rehabilitation or treatment\$ or therapeutic\$ or computer-assisted therap\$ or computer assisted therap\$):ti,ab,kw (Word variations have been searched)

#12 MeSH descriptor: [Rehabilitation] explode all trees

#13 MeSH descriptor: [Therapeutics] explode all trees

#14 MeSH descriptor: [Cognitive Therapy] explode all trees

#15 MeSH descriptor: [Computers] explode all trees
 #16 MeSH descriptor: [Therapy, Computer-Assisted] explode all trees
 #17 MeSH descriptor: [Psychological Tests] explode all trees
 #18 (neurorehabilitation or neuropsychological rehabilitation or cognitive rehabilitation or memory rehabilitation or cognitive retraining):ti,ab,kw (Word variations have been searched)
 #19 {or #11-#18}
 #20 #10 and #19
 #21 #20 and #3
 #22 adult or aged or "aged, 80 and over" or middle aged
 #23 #21 and #22

Appendix 2. MEDLINE (Ovid) search strategy

The following search strategy was used for MEDLINE (Ovid) and modified for the other databases.

1. exp Cerebrovascular Disorders/
2. (stroke\$ or cerebrovascular\$ or cerebral vascular or CVA\$).tw.
3. 1 or 2
4. attention/ or exp cognition/ or exp memory/ or exp cognition disorders/ or exp memory disorders/
5. (cognitive or cognition or attention\$ or memory or concentration or distract\$ or alert\$).tw.
6. 4 or 5
7. (training or re-training or retraining or therap\$ or rehabilitation or treatment\$ or therapeutic\$ or computer-assisted therap\$ or computer assisted therap\$).tw.
8. exp rehabilitation/
9. exp therapeutics/
10. exp cognitive therapy/
11. exp computers/
12. exp therapy, computer-assisted/
13. exp neuropsychological tests/
14. or/7-13
15. 6 and 14
16. (neurorehabilitation or neuropsychological rehabilitation or cognitive rehabilitation or memory rehabilitation or cognitive retraining).tw.
17. 15 or 16
18. 3 and 17
19. Randomized Controlled Trials/
20. random allocation/ or placebos/
21. Controlled Clinical Trials/
22. clinical trials/
23. randomized controlled trial.pt.
24. controlled clinical trial.pt.
25. clinical trial.pt.
26. (random\$ or placebo\$).tw.
27. (controlled adj5 (trial\$ or stud\$)).tw.
28. (clinical\$ adj5 trial\$).tw.
29. or/19-28
30. 18 and 29
31. limit 30 to humans
32. adult/ or aged/ or "aged, 80 and over"/ or middle aged/
33. 31 and 32
34. limit 33 to yr="2005-Current"
35. remove duplicates from 34

Appendix 3. EMBASE (Ovid) search strategy

The following search strategy was used for EMBASE (Ovid):

1. exp Cerebrovascular Disorders/
2. (stroke\$ or cerebrovascular\$ or cerebral vascular or CVA\$).tw.
3. 1 or 2
4. attention/ or exp cognition/ or exp memory/ or exp cognition disorders/ or exp memory disorders/
5. (cognitive or cognition or attention\$ or memory or concentration or distract\$ or alert\$).tw.
6. 4 or 5
7. (training or re-training or retraining or therap\$ or rehabilitation or treatment\$ or therapeutic\$ or computer-assisted therap\$ or computer assisted therap\$).tw.
8. exp rehabilitation/
9. exp therapeutics/
10. exp cognitive therapy/
11. exp computers/
12. exp therapy, computer-assisted/
13. exp neuropsychological tests/
14. or/7-13
15. 6 and 14
16. (neurorehabilitation or neuropsychological rehabilitation or cognitive rehabilitation or memory rehabilitation or cognitive retraining).tw.
17. 15 or 16
18. 3 and 17
19. Randomized Controlled Trials/
20. random allocation/ or placebos/
21. Controlled Clinical Trials/
22. clinical trials/
23. randomized controlled trial.pt.
24. controlled clinical trial.pt.
25. clinical trial.pt.
26. (random\$ or placebo\$).tw.
27. (controlled adj5 (trial\$ or stud\$)).tw.
28. (clinical\$ adj5 trial\$).tw.
29. or/19-28
30. 18 and 29
31. limit 30 to humans
32. limit 33 to yr="2005-Current"
33. remove duplicates from 32
34. limit 33 to ("all adult (19 plus years)" or "young adult (19 to 24 years)" or "adult (19 to 44 years)" or "young adult and adult (19-24 and 19-44)" or "middle age (45 to 64 years)" or "middle aged (45 plus years)" or "all aged (65 and over)" or "aged (80 and over)" or "300 adulthood <age 18 yrs and older>" or 320 young adulthood <age 18 to 29 yrs> or 340 thirties <age 30 to 39 yrs> or 360 middle age <age 40 to 64 yrs> or "380 aged <age 65 yrs and older>" or "390 very old <age 85 yrs and older>")
35. limit 34 to adulthood <18+ years>
36. limit 35 to (adult <18 to 64 years> or aged <65+ years>)

Appendix 4. Trial registries search strategy

The following search terms were used for trial registries:

Stroke, Cerebrovascular Disorders, Cerebral Vascular Accident (CVA), CVA, Cerebra*, Cerebro*, Memory Disorders, Cognition Disorders, Attention, Cognition, Memory, Cognitive
Cognitive Rehabilitation, Stroke Rehabilitation, Tele-rehabilitation, Rehabilitation, Training, Retraining, Therapy, Therap*, Treatment, Computer, Neuropsychological Testing
Randomised, Control, Randomised Controlled Trials
Adults (18+), Older adults, Young adults, Aged, Middle aged
2005-2016, 2005-current

WHAT'S NEW

Last assessed as up-to-date: 19 May 2016.

Date	Event	Description
19 May 2016	New citation required and conclusions have changed	The conclusions have changed. The overall conclusions of the review now show limited evidence to support the benefits from the intervention on subjective measures of memory in the short term. There remains insufficient evidence to support or refute the effectiveness of memory rehabilitation on objective memory measures, functional abilities, mood, or quality of life
19 May 2016	New search has been performed	New searches have been updated and completed to 19 May 2016. The review now includes 13 trials involving 514 participants. Eleven studies have been added Das Nair 2007 and Westerberg 2003 have been moved from 'Ongoing studies' and 'Studies awaiting classification' into 'Included studies' In this version of the review we assessed the risk of bias in all new and existing studies, we assessed the quality of the evidence from the included studies using the GRADE approach, and we added a 'Summary of findings' table The review team has changed.

HISTORY

Protocol first published: Issue 2, 2000

Review first published: Issue 2, 2000

Date	Event	Description
4 August 2008	Amended	Converted to new review format.
19 March 2007	New search has been performed	One new trial, Kaschel 2002 , has been included in the review since the previous version. The overall conclusions of the review have not changed
19 March 2007	New citation required but conclusions have not changed	Change to authorship.

CONTRIBUTIONS OF AUTHORS

Roshan das Nair (RdN) developed the search strategies and the template to assess the quality of the studies included, collected the data, and revised the final review.

Nadina Lincoln (NBL) initiated, co-ordinated and designed the format of the review, appraised the studies for review, and revised the final report.

Heather Cogger (HC) and Esme Worthington (EW) conducted the literature searches, extracted the data from studies, appraised the quality of the included studies, and prepared the early drafts of the review.

DECLARATIONS OF INTEREST

Roshan das Nair: was involved in one of the trials included in this review.

Heather Cogger: none known.

Esme Worthington: none known.

Nadina B Lincoln: was involved in one of the trials included in this review.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- NIHR Cochrane Review Incentive Scheme 2015, UK.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In the previous review, we considered functional measures (including quality of life) as the primary outcome of interest for memory rehabilitation. However, we believe that while this is still a goal of memory rehabilitation, quality of life is perhaps too distal an outcome, which can be influenced by a variety of factors that may not be related to the intervention. We therefore felt that a subjective rating of problems related to memory in daily life was a more realistic yet meaningful outcome for participants who have had memory rehabilitation. Thus, for this update, we have considered the extent of memory problems in everyday life as the primary outcome. Compared to the previous version, we have expanded the description of outcome measures with greater detail and have updated the methods to include the use of the 'Risk of bias' tool and GRADE methods.

INDEX TERMS

Medical Subject Headings (MeSH)

Attention; Clinical Trials as Topic; Cognition; Memory Disorders [etiology; *rehabilitation]; Perception; Stroke [*complications]

MeSH check words

Humans