Memory training effects in old age as markers of plasticity: a meta-analysis
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CRD summary
Evidence on the effectiveness of memory training interventions for older adults was scarce. Significant benefits were found for some outcomes when compared with no contact controls, but less benefit was seen compared with active controls. Due to methodological shortcomings the conclusions of this review should not be considered as reliable.

Authors' objectives
To review the effect of memory training for old healthy people and people with mild cognitive impairment.

Searching
PsycINFO, Web of Knowledge and PubMed were searched from 1970 to September 2007. The Specialised Register of the Cochrane Dementia and Cognitive Improvement Group was searched in September 2007. Search terms were reported. Papers published in English or German in peer-reviewed journals were considered for inclusion. References from relevant papers were scanned.

Study selection
Randomised controlled trials (RCTs) that compared a memory training intervention with no contact or an active control in any setting were eligible. The population of interest was males and females aged 60 years or over who were either healthy or met criteria for mild cognitive impairment. Diagnosis of dementia was an exclusion criteria. Studies were required to report cognitive outcome measures and report a baseline and post-intervention assessment.

Most of the included trials involved healthy old people. Mean age across all trials was 69.9 years. The memory interventions largely used multifactorial training strategies; some also incorporated pharmacological treatments. The number of training sessions ranged (in hours) from six to 135. Overall duration ranged from one day to one year. Most interventions used group settings. The most commonly reported outcome domains were face-name immediate recall, face-name delayed recall, visuospatial memory, short-term memory, paired associates, immediate recall and delayed recall.

Studies were selected by four reviewers working independently. Final decisions were made by consensus.

Assessment of study quality
Quality assessment was based on Cochrane Reviewers Handbook guidance and appeared to assess only allocation concealment Trials were graded as adequate, intermediate or inadequate and those judged as adequate or intermediate were included in the review.

It was not clear how many reviewers performed the quality assessment.

Data extraction
Within each study, each outcome scale change from baseline was extracted as mean and standard deviation. For crossover trials only first period data were used. Where a study reported several comparator groups each control-active treatment comparison was entered as a separate study. If change from baseline was not reported, this was calculated based on data available assuming no correlation between baseline and final assessment measures. Intention-to-treat data were extracted where possible.

It was not clear how many reviewers performed the data extraction.

Methods of synthesis
A fixed-effect model was used to calculate pooled mean differences and 95% confidence intervals (CI) except where
heterogeneity was present ($I^2 > 50\%$), when a random-effects model was used. Studies were grouped according to population (healthy older adult, mild cognitive impairment), control (active, no contact) and memory aspect (immediate and delayed recall of words, paragraphs or stories, face-name recall, paired associate learning, visuospatial and short-term learning).

**Results of the review**
The text reported a total of 24 RCTs (n=2,229). Three studies reported on adults with mild cognitive impairment. Study details in the appendix detailed 25 trials, one of which did not report overall n. For most trials allocation concealment was judged to be unclear.

Healthy older adults performances were significantly improved compared with no contact controls on the three outcomes: paired associate learning (2.71, 95% CI 1.65 to 3.78; three RCTs), immediate verbal recall (0.16, 95% CI 0.06 to 0.26; 23 RCTs) and delayed verbal recall (0.88, 95% CI 0.26 to 1.51; 13 RCTs). Substantial statistical heterogeneity was present for immediate recall ($I^2 = 52\%$) and delayed recall ($I^2 = 48\%$). There were no significant differences in face-name immediate recall (four RCTs), face-name delayed recall (three RCTs), visuospatial memory (three RCTs) or short-term memory (six RCTs).

Healthy adults who received active control versus memory training improved significantly in face-name immediate recall (0.93, 95% CI 0.41 to 1.44; 10 RCTs) and performed less well on visuospatial memory (-0.94, 95% CI -1.66 to -0.22; three RCTs). Statistical heterogeneity was present for immediate recall ($I^2 = 45\%$) and visuo-spatial memory ($I^2 = 82\%$). There were no significant differences in face-name delayed recall (three RCTs), short-term memory (six RCTs), paired associates (four RCTs), immediate recall (19 RCTs) and delayed recall (10 RCTs).

Adults with mild cognitive impairment who received memory training displayed significant improvements in immediate recall versus no contact controls (1.73, 95% CI 0.10 to 3.37; five RCTs) with no heterogeneity, but not for delayed recall (four RCTs). Drug therapy produced significantly better results than memory training for immediate recall (-2.36, 95% CI -11.52 to 6.79; two RCTs) with substantial heterogeneity ($I^2 = 72\%$).

**Authors’ conclusions**
Evidence on the effectiveness of memory training interventions for older adults was scarce. Significant benefits were found for some outcomes when compared with no contact controls, but less benefit was seen compared with active controls.

**CRD commentary**
This review addressed a clear question with detailed inclusion criteria and a reasonable range of databases. English and German papers were eligible. Only published studies were considered, which potentially introduced publication bias. The review processes (except for study selection) were not clearly described, which made it difficult to rule out reviewer error/bias. Validity assessment was limited to a single criterion and gave little indication of the reliability of the primary studies. The analyses may not have been appropriate due to the clinical heterogeneity of included studies. The decision to enter more than one comparison from some studies violated the principle of independence between study results and may have affected the results. Due to methodological shortcomings the conclusions of this review should not be considered as reliable.

**Implications of the review for practice and research**
The authors did not state any recommendations for practice.

**Research:** The authors recommended that future research should be of high methodological quality with standardised treatment protocols and outcome measures. Recruitment of homogeneous samples and use of a consistent definition of mild cognitive impairment would be helpful.

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