For adults with traumatic brain injury, evidence does not support the remedial approach for memory, but does support attentional remediation for those with mild impairment, although lacks in demonstrating functional outcomes and in comparing effectiveness with the compensatory approach.

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CLINICAL SCENARIO: There are two primary approaches to cognitive rehabilitation for adults with traumatic brain injury (TBI), the remedial approach (deficit-specific skills training such as table-top activities and repetitive drills) and the adaptive or compensatory approach (adapting tasks, routines and environments). A primary goal of occupational therapy (OT) in cognitive rehabilitation is to enhance the client's functional abilities. The adaptive (compensatory) approach is the prevalent practice at the GF Strong Rehab Centre in Vancouver. However, clients often request remedial exercises, for example to improve memory, and the neuropsychologists now offer an attention training group. Is there evidence to support a larger role for the remedial approach in OT intervention?

FOCUSED CLINICAL QUESTION: For adults with traumatic brain injury (TBI) and resulting attention and memory deficits, is cognitive remediation as effective or more effective than a compensatory approach in improving functional performance for daily activities?

SUMMARY of Search:

- 1 review on TBI rehabilitation (Gordon et al., 2006)
- 3 systematic reviews on cognitive rehabilitation (Cappa et al., 2005; Cicerone et al., 2005; Carney et al., 1999)
- 3 systematic reviews on attention rehabilitation (Riccio & French, 2004; Solhberg et al., 2003; Park & Ingles, 2001)
- 1 narrative review on attention rehabilitation (Michel & Mateer, 2006)
- numerous single studies of varying levels of evidence, each also found within one or more of the reviews

CLINICAL BOTTOM LINE:

There is some evidence in terms of psychometric outcomes to support attention remediation, in particular attention process training (APT), in post-acute settings and for individuals with mild deficits. Internal strategy training (metacognitive training) may be a key component. There is limited evidence addressing attention remediation in terms of functional outcomes; more research is required.

Memory remediation, including use of computers, has been found to be ineffective. There is some evidence that internal strategy training, immediate feedback and errorless learning may be effective for new learning, in particular for individuals with mild deficits. For the compensatory approach, the evidence is strong for individuals with mild deficits, and weaker for individuals with moderate to severe impairment.

There are no studies to date comparing the effectiveness of attention or memory remediation to the use of external cognitive compensatory strategies.

Limitation of this CAT: This critically appraised topic has not been subject to peer review.

SEARCH STRATEGY:

Databases and sites searched	Search Terms	Limits used
• CINAHL • MEDLINE • PsycINFO • EBM Reviews (Cochrane Database of Systematic Reviews, Cochrane Central Registry of Controlled Trials, ACP Journal Club, Database of Reviews and Effects) • EMBASE • OT Seeker	*Various combinations of*: *Population*: brain injur*, head injur*, memory, attention *Intervention and comparison*: cogniti*, rehabilitat*, remediat*, train*, treat*, therapy, compensat*, exercise*, restor* *Outcomes*: function, productive*, work, leisure, self care, outcome, effect, evidence	• 1994 to 2007 • adults • English • human • Evidence-based practice (*used on second round of searches*)

INCLUSION and EXCLUSION CRITERIA

- Inclusion:
  - remedial approach, or both remedial and compensatory
  - addresses attention and/or memory
  - systematic review, meta-analysis, controlled trial or well-designed cohort study

- Exclusion:
  - diagnosis other than traumatic brain injury
  - paediatrics, geriatrics
  - does not distinguish between effects of remedial and compensatory approach
  - compensatory approach as sole focus
  - case studies
  - expert opinion, statement paper, or general description of cognitive rehabilitation, without any evidence review or critical appraisal
  - editorial or commentary
  - systematic reviews that have since been updated by same authors
  - initially, studies were to be excluded if no functional outcomes measured, but it became readily apparent that very few studies considered functional outcome measures to any degree (thus, this exclusion criterion was abandoned)

RESULTS OF SEARCH

The search resulted in over 100 hits. Based on inclusion and exclusion criteria, 11 studies were considered relevant, and categorised as shown in Table 1 (based on Levels of Evidence, Oxford Centre for Evidence-based Medicine, Phillips et al. 2001).

Table 1: Summary of Study Designs for Studies Identified as Relevant

Study Design/ Methodology of Articles Retrieved	**Level of Evidence**	**Author (Year)**
Systematic Review	1a-, 2a-, 3a-	•Cappa et al. (2005) •Cicerone et al. (2005) •Riccio & French (2004) •Sohlberg et al. (2003) •Park & Ingles (2001) •Carney et al. (1999)
Quasi-experimental randomized control trial	2b	•Tam & Man (2004)
Cohort study	2b	•Cicerone (2002)
Narrative Review *(*initially thought to be systematic reviews, thus included in final list of relevant studies)*	5	•Michel & Mateer (2006) •Gordon et al. (2006) •NIH Consensus (1999)

BEST EVIDENCE

The following papers were identified as the 'best' evidence and selected for critical appraisal.

1. Practice guidelines for attention training. (Sohlberg et al., 2003)

2. Evaluating computer-assisted memory retraining programmes for people with post-head injury amnesia. (Tam & Man, 2004)

3. Evidence-based cognitive rehabilitation: Updated review of the literature from 1998-2002. (Cicerone et al., 2005)

4. EFNS guidelines on cognitive rehabilitation: Report on an EFNS task force. (Cappa et al., 2005)

Reasons for selecting these papers were that they are the highest levels of evidence, and for the systematic reviews, the most rigorous (in terms of number of studies reviewed and methodology) and most up-to-date. Tam and Man (2004) and Cicerone (2002) are at an equivalent level of evidence, but Cicerone (2002) is well appraised in a subsequent review (Cicerone et al. 2005), whereas the critical appraisal of Tam and Man (2004) in Cappa et al. (2005) is poor, and thus felt to be worth reviewing for this CAT.

SUMMARY OF BEST EVIDENCE

Table 2: Description and appraisal of: Practice guidelines for attention training. (Sohlberg et al., 2003)

Purpose: To examine the literature for evidence of effectiveness of direct attention training following traumatic brain injury (TBI). **Design**: Systematic review of 9 studies. These consisted of all of the Class I and II studies (total 6) from 2 previous reviews (Cicerone et al., 2000, and Park & Ingles, 2001), plus 3 additional studies found in an updated search, 1999 to 2002 (PsychINFO, MEDLINE/PubMed, ERIC, CINAHL).
Methods: Two reviewers, reaching consensus, and then results analysed by committee of researchers and clinicians. Each study was reviewed in terms of 5 questions: • "Who are the participants?" • "What comprises attention training?"

- "Are there methodological concerns?"
- "What are the outcomes?"
- "Are there clinically applicable trends?"

Original Authors' Conclusions:

- Attention training with metacognitive training is recommended, for clients with mild impairment and in the post-acute stage of recovery. This is given as a "practice guideline" (defined as a recommendation for client management reflecting moderate clinical certainty, from Class II evidence or strong consensus of Class III evidence).
- Generalization is of results is unknown (to untrained tasks, function).
- Of note, the authors also opined that if studies of *memory* remediation (memory drills) had been subject to the 5 questions considered in the current review, then this would have been discarded as ineffective much earlier than it was.

***Critical Appraisal*:**

Validity (methodology, rigor, selection, bias): The researchers performed a comprehensive search, locating studies from 2 previous systematic reviews as well as updating findings using numerous appropriate databases. This assumes that the 2 previous reviews were comprehensive; I question whether Cicerone (2000) was; but I agree that Park and Ingles (2001) was. There was a high level of rigour, with analysis only of Class I and II studies (although trends could not be determined such as from Class III studies), and using very clinically relevant questions as criteria, including consideration of functional outcomes. The conclusions appear accurate based on results presented.

Implications for Practice/Applicability: The conclusions have only some usefulness in answering the clinical question of this CAT. They provide some support for providing attention training interventions to brain injury clients. However, as functional outcomes are unknown, the clinician would need to be cautious in dedicating resources to implementing attention training interventions (one-to-one or group).

Useful information provided by the authors is that memory remediation (in particular memory drills) had already been discarded as ineffective, with some references provided that the clinician can review for further confirmation of this finding.

Table 3: Description and appraisal of: Evaluating computer-assisted memory retraining programmes for people with post-head injury amnesia. (Tam & Man, 2004)

Purpose: To compare the effectiveness of computer assisted cognitive rehabilitation (CACR) in improving memory skills of TBI persons.

Study Design: Randomized control trial, given as quasi-experimental (acknowledged to have limitations including small sample sizes and difficulty obtaining true random sampling). This was developed as a pilot investigation of potential attributes of CACR. Set up as A-B-A design.

Setting: The study took place in a number of hospitals in Hong Kong (not given if subjects were inpatients and/or outpatients).

Participants: There were 26 subjects, age 18 to 45, divided into 4 treatment groups; and one control group of 8. Groups were matched diagnostically and demographically. Subjects were recruited from various hospitals. They were included if >3 months post closed head injury; reported to have post-brain injury short term memory impairment, Rivermead Behavioural Memory Test score of <15; excluded if severe visual deficits, physical impairment precluding

access of keyboard or mouse, premorbid mental retardation or other neurological pathology. No information given as to whether there were drop-outs.

Intervention: Treatment subjects attended 10 sessions, using computer software developed by the researchers. There were 4 modules, each relating to memory components for daily function (similar to the different memory areas tested by the Rivermead – remembering faces and names, to do something, what people tell, and where to put something). This included internal strategy training (hints provided to help remember information, such as to get meaning out of a name, use visual imagery, split long names into short ones, etc.). The authors presented 4 different advantages that may be offered by CACR, and the for each treatment group, there was an emphasis on one these "advantages": self-paced, thus allowed to work at own pace in non-threatening environment; immediate feedback provided; personalized, thus actual people, objects etc. from subject's own life; and visual presentation, thus attractive, bright and colourful. The control group received no intervention.

Outcome Measures: Prior and post-intervention, all groups were measured using the Rivermead Behavioural Memory Test (different version for pre and post); and using a self-efficacy rating scale that had been developed by the researchers, which measured the extent which subjects felt capable of using specific strategies in memory tasks. In addition, the treatment groups (but not the control group) were assessed using a computer quiz (performance on the drilled component of each program).

Results: Analysis of results, comparing pre- and post-treatment scores
* = significant, $p<0.05$; n.s. = not significant

	Computer quiz	Rivermead	Self-efficacy rating
Self-pace group	2.54*	0.72 n.s.	0.25 n.s.
Feedback group	3.00*	0.08 n.s.	2.32*
Personalized group	3.4*	0.97 n.s.	0.43 n.s.
Visual presentation group	3.15*	1.56 n.s.	0.84 n.s.
Control group	(*not tested*)	1.07 n.s.	0.07 n.s.

Original Authors' Conclusions:

- The results provided evidence of the effectiveness of CACR.
- The finding that the 4 treatment groups did not show statistically significant different in memory outcomes, as measured by the Rivermead, might be owing to the Rivermead not being sensitive enough to detect the memory skill improvement brought about by CACR
- Feedback is a crucial factor to improving self-efficacy in applying memory strategies, as indicated by results of self-efficacy ratings.
- All of the unique characteristics ("advantages") of CACR were demonstrated.
- The results may be generalized to other CACR, such as attention, reaction ability, etc.

***Critical Appraisal*:**

Validity (methodology, rigor, selection, bias): As indicated by the authors, there were some limitations in selection of subjects. Unfortunately, the level of injury is not stated (mild, moderate or severe brain injury), making it difficult to replicate the study. It would also not be possible to replicate the study because the software used is not commercially available; and the self-efficacy outcome scale is not published.

The authors' interpretation of results, in arriving at their conclusions, is very poor. The conclusions do not represent the results presented by the authors. The results do NOT support the use of CACR. Yes, all treatment groups improved in computer quiz scores, but as the control group was not tested, practice effects or other factors cannot be discounted. Even though all treatment groups improved for Rivermead scores, so did the control group, and no

improvements had statistical significance. The authors felt that the Rivermead may not have been sensitive enough to improved memory. However, what use is an intervention if it results in only very slight improvement (such as might be measured by a very sensitive tool). The only statistically significant positive outcome was that individuals who received immediate feedback during training felt more capable of implementing memory strategies. However, there is no measure of whether or not they actually did so, such as in functional activities.

Implications for practice/applicability: The results do not support use of CACR as a remedial intervention for memory, and instead, support not using CACR.

Table 4: **Description and appraisal of:** Evidence-based cognitive rehabilitation: Updated review of the literature from 1998-2002. (Cicerone et al., 2005)

Purpose: To provide evidence-based recommendations for practice for cognitive rehabilitation of individuals with stroke or TBI, updating previous review (Cicerone et al., 2000), both by American Congress of Rehabilitation Medicine (ACRM)

Design: Systematic review of 87 studies total, relating to 7 primary areas of cognition, with 5 studies relating to attention, and 13 studies to memory. A search was carried out from 1998 to 2002, using PubMed and MEDLINE. In addition, results of a previous review (Cicerone et al, 2000), were considered (thus, studies up to 1997).

Methods: Two to three reviewers, reaching consensus, categorizing studies in terms of each study's level of evidence: Class I, Class II or Class III. This allowed for recommendations to be presented as:

- *Practice standard*: based on highest levels of evidence, as least one well-designed Class I study, with support from Class II or III evidence;
- *Practice guideline*: based on moderate levels of evidence, such as Class I studies with methodological limitations, or well-designed Class II studies.
- *Practice opinion*: based on Class II or III studies.

Original Authors' Conclusions:

- Attention training with internal strategy training is recommended for post-acute rehabilitation (*practice standard*).
- There is insufficient evidence to support interventions for acute rehabilitation.
- Memory: internal strategy training recommended for mild impairment to address memory (*practice standard*).
- Memory: CACR not recommended (*practice opinion*).
- Memory: external compensatory strategies recommended for mild impairment (*practice standard*) and moderate to severe impairment (*practice guideline*).

***Critical Appraisal*:**

Validity (methodology, rigor, selection, bias): The researchers did not appear to have undertaken a very comprehensive search, using only 2 databases. The lack of studies could not be accounted for by exclusion criteria. The authors' conclusions were accurate based on results presented, but conclusions may have differed if more studies had been reviewed. Of note was that self-report outcomes as presented in some studies reviewed provide some indication of positive functional outcomes, but this was not discussed by the authors or considered in terms of their practice standards or guidelines. Instead, the standards and guidelines are based only on the level of evidence in studies reviewed, and are not as clinically relevant as the criteria used in a previous review, Sohlberg et al. (2003).

Implications for Practice/Applicability: The conclusions have some usefulness in answering the clinical question of this CAT. They further support use of attention training and use of internal strategy (metacognitive) training. Conclusions also further support that memory remediation, including CACR, is not recommended for memory training. There was some indication of positive functional outcomes, although this needs further research. There was no comparison of remedial and compensatory approaches.

Table 5: Description and appraisal of: EFNS guidelines on cognitive rehabilitation: Report on an EFNS task force. (Cappa et al., 2005)

Purpose: To provide an updated and revised evaluation of evidence for cognitive rehabilitation in stroke and TBI, with practice recommendations, to update previous review (Cappa et al., 2003), both conducted by the European Federation of Neurological Societies (EFNS).

Design: Systematic review, with the search carried out using MEDLINE, PsychINFO, Cochrane; textbooks; and existing guidelines. There was no information provided explicitly regarding number of studies, dates, search terms or exclusion criteria (and this information is also lacking in Cappa et al., 2003). From the reference list and narrative, I identified that 13 attention studies and 25 memory studies were reviewed, from 1985 to 2004 (thus including Cappa et al., 2003 review).

Methods: One reviewer for studies on attention and one for studies on memory. Each study was rated in terms of its level of evidence (Class I to Class IV). This allowed for recommendations to be provided as:

- *Grade A*: based on Class I studies
- *Grade B*: based on Class II and III studies
- *Grade C*: based on Class IV studies

All recommendations were determined by consensus of all reviewers.

Original Authors' Conclusions:

- Attention: *Grade A* recommendation given for attention training during post-acute phase. There is no evidence to support attention training during the acute phase.
- Memory: *Grade C* recommendation given for remedial strategies, with a *Grade B* recommendation given for "errorless learning". Benefits are unclear relating to specific impairment levels.
- Memory, use of external compensatory aids: *Grade C* recommendation given for non-electronic compensatory aids (e.g. diaries); and *Grade B* recommendation given for electronic aids (e.g. pagers).

***Critical Appraisal*:**

Validity (methodology, rigor, selection, bias): Although this review was more updated than Cicerone et al. (2005), there were a limited number of studies found, despite considering the wide range of years included, for example as compared to the number of studies presented in other reviews. The authors' conclusions were accurate based on the results presented, but conclusions may have differed if more studies had been reviewed. Of note is that findings were consistent with Cicerone et al., despite there being little overlap in the specific studies each reviewed. The use of internal strategy training was not addressed in the authors' conclusions, although was identified in the narrative review of studies. As with previous reviews, functional outcomes were not addressed, and there was no comparison of remedial and compensatory approaches. Unfortunately, the authors grouped CACR together with computerized external compensatory aids, rather than acknowledging these as different approaches to intervention, and making it difficult for the reader to have confidence in their

recommendations for electronic aids. I also have reduced confidence in the authors' extent of critical appraisal. For example, their appraisal of Tam and Man (2004) indicates reliance on conclusions, which I had found unsupported by results.

Implications for Practice/Applicability: The conclusions further support attention training during the post-acute phase, and also provide further support to not use memory remediation. However, as with previous reviews, functional outcomes were not addressed such as for attention training interventions, and there was no comparison of remedial and compensatory approaches.

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

The following summary, as applies to the clinical question of this CAT, is based on the aggregate results, conclusions and critical appraisals of the 4 studies reviewed:

1. Attention training, perhaps specifically attention process training may have value for clients with traumatic brain injury (TBI), in post-acute settings for mild impairment. Internal strategy (metacognitive) training may be key. However, there is no evidence to date that attention remediation results in improved function, or is as effective as compensatory strategies.

2. There is little if any value in memory remediation for TBI, e.g. memory drills, CACR. The compensatory approach continues to be the strongest practice recommendation. Internal strategy training, provision of immediate feedback, and errorless learning may be key for new learning, but perhaps only successful for clients with mild impairments.

3. More research is required to identify the effect of attention remediation on function for day-to-day activities, and in comparing effectiveness of this intervention with other cognitive rehabilitation approaches relating to functional outcomes. More research is required to identify specific strategies that are effective for new learning, in particular in terms of functional outcomes, and the TBI populations that may benefit the most (mild, moderate and/or severe).

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