AOTA Critically Appraised Topics and Papers Series

Traumatic Brain Injury

*A product of the American Occupational Therapy Association's Evidence-Based Literature Review Project

CRITICALLY APPRAISED TOPIC (CAT)

Focused Question #4

What is the evidence for the effect of interventions to address cognitive/perceptual functions (attention, memory, executive functions) on the occupational performance for persons with traumatic brain injury (TBI)?

Clinical Scenario:

The most disabling impairments following TBI, whether the injury is mild or severe, are cognitive (Blundon & Smits, 2000; Cicerone, Dahlberg, Kalmar, Langenbahn, Malec, Berquist, et al., 2000); that is, disturbed executive function (defined as those integrative processes that determine goal-directed and purposeful behavior and are superordinate in the orderly execution of daily life functions [Cicerone et al., 2004 and include reasoning, planning, concept formation, mental flexibility, aspects of attention and awareness, and purposeful behavior [McDonald, Flashman, & Saykin, 2002]), attention (e.g., processing speed, focused attention, divided attention), and/or prospective memory (the ability to remember to do things at the appropriate time; Raskin & Sohlberg, 1996). Ninety-five percent of rehabilitation facilities serving people with TBI provide some form of cognitive rehabilitation, including combinations of individual and group and community-based therapies (Cicerone et al., 2004). As part of these rehabilitation programs, occupational therapists utilize various interventions to remediate these impairments or to compensate for their effects on occupational performance (Blundon & Smits, 2000; Wade & Troy, 2001). Extensive time is devoted to cognitive rehabilitation; therefore, the effectiveness of this therapy needs to be documented.

Summary of Key Findings:

Summary of Levels I, II, and III

- **Executive Function**

Two studies were reviewed in this area, both of which were rated Level I. Each study examined a different intervention.

Levine, Robertson, Clare, Carter, Hong, Wilson, et al., (2000) used a randomized controlled trial to examine the effects of **Goal Management Training (GMT)** versus a motor skills training (MST) program (control) on everyday paper-and-pencil tasks for people with TBI to the frontal lobes. Goal management training included orienting to relevant goals, selecting goals, portioning goals into subgoals, encoding and retaining goals and subgoals, and monitoring the outcome of action compared with goal state. The researchers found a significant difference in accuracy between groups on a proofreading task, but the difference was due to more errors by controls rather than improvement by experimental participants. The GMT group performed significantly better on the grouping task than did the MST group and the effect was moderately strong ($F_{1, 28} = 5.56$, $p < .05$, $r = .41$). There was no significant difference in groups on the room layout task; both improved. The authors concluded that GMT was associated with improved performance on paper-and-pencil tasks that correspond to everyday situations known to be problematic for people with TBI. However, there was only one finding of differential improvement (grouping task), which may have been because the tasks used to measure outcome were similar to those used in GMT (task-specific training). This study had several other flaws, including failure to report information concerning the validity and reliability of the outcome measures or whether the evaluator was blind to group assignment.

Manly, Hawkins, Evans, Woldt, and Robertson (2002) used a one-group repeated measures crossover design with random assignment to condition to examine whether **auditory stimuli that interrupted current activity** would cause patients to pause, evaluate, plan, and change track and thereby improve performance of a complex (multi-step) task. The control condition required the same tasks of the participants, but there was no alerting beep. Intervention was applied in one 15-minute period in a laboratory. There was a significant improvement in number of tasks started in the alerting condition compared to the control condition and the effect was strong ($F_{(1,9)} = 5.44$, $p < 0.05$, $r = .61$). Under the alerted condition the participants allocated their time during each task significantly better than under the control condition ($F_{(1,9)} = 15.22$, $P < 0.01$, $r = .79$). There was no significant difference between conditions in time spent in each activity, in time-specific responses, or in use of the clock. The alert did not prompt a switch in tasks ($F_{(1,9)} = 0.47$, $p = 0.51$, $r = .22$). The authors concluded that the performance was significantly improved when exposed to periodic, nonpredictive tones. The study was flawed in that the validity and reliability of outcome measurement were not reported.

Recommendation: The fairly strong Level I study by Manly, et al. (2002) suggests one possibly useful compensatory intervention for people with impaired executive function after a TBI—using alerting beeps to catch the patient's attention and switch focus of performance. However, one study of 10 patients undergoing one 15-minute experimental treatment cannot establish this intervention as predictably effective.

- **Attention**

Three studies were reviewed in this area including one meta-analysis and two Level I studies.

Park and Ingles (2001) performed a meta-analysis on 20 studies, involving 359 patients, concerning the efficacy of current **attention rehabilitation** after acquired brain injury, specifically to determine whether direct-training and specific-skill programs differ in their

effectiveness. The interventions included both auditory and visual exercises. Eighty-three percent of the studies specified that the tasks were graduated in difficulty; 77% of the studies indicated that feedback on training performance was provided. The number of training tasks varied, with 50% of the studies providing 5 or more tasks. Eighty-nine percent of the programs had a component in which speeded or paced performance was encouraged. In 50% of the studies, treatment was via computer. Mean treatment time was 31 hours. Park and Ingles concluded that acquired deficits of attention are treatable and that learning that occurs as a function of training is specific and does not generalize to tasks that differ considerably from those used in training. They further concluded that more study is needed in how to best train a person with brain damage.

Sohlberg, McLaughlin, Pavese, Heidrich, and Posner (2000; Level I), using a two group crossover design with random assignment to group, examined **Attention Process Therapy (APT),** operationally defined as hierarchical organization of tasks that exercise different components of attention: sustained, selective, alternating, and divided, as compared to brain injury education, supportive listening, and relaxation training on the participants' perceptions (by questionnaire) of the impact of attention deficits on daily living and (by interview) whether the participants noticed any changes in their day-to-day lives that they felt had been due to participating in therapy. The number of changes reported in interview were significantly greater after APT than after education ($F_{(1, 10)} = 5$, $P < 0.05$, $r = .58$). The analysis of the questionnaires indicated significant improvements reported over time ($F_{(6,50)} = 3.36$, $p < 0.01$) that were not associated with type of treatment ($F_{(3,8)} < 1$, $p > .65$). The authors concluded that practice, whether by repeating the assessment tasks or participating in the training of general processes using APT, improves performance. In addition, they concluded that teaching about brain injury issues appears to improve the patients' attitude. In the authors' opinion, the significant finding of this study was that for low-vigilance participants, APT resulted in improved attention skills, which generalized to measures that were different from training tasks. The limitations of concern for this study include unequal group characteristics at the start of study, despite random assignment to group; and that the experimental treatment was administered at 2½ times the intensity of the control treatment.

Novack, Caldwell, Duke, Bergquist, and Gage (1996; Level I), using a matched pairs randomized trial, studied the effect of **a focused attention remediation program** versus an unstructured stimulation program (control) on *FIM* (*Functional Independence Measure*) scores, a measure of basic self-care and caregiver burden. Participants had severe TBI and were in the acute stage of recovery. There was no significant difference between groups at admission. Each treatment was administered for 30 minutes, 5 days per week for 1 to 15 weeks. The experimental treatment was administered at 2½ times the intensity of the control treatment, an important limitation of the study. There was no significant difference between groups at discharge; however, there was a significant effect for time ($F_{(7,36)} = 14.21$, $p < .0001$), indicating that spontaneous recovery may have occurred. The authors concluded that focused remediation is no more effective than unstructured stimulation in improving the attention skills of individuals undergoing acute rehabilitation following severe TBI. The *FIM*, the outcome measure of interest to this review, was introduced halfway through the 3-year study; therefore, it was administered to only 24 out of 44 participants.

Conclusions from these studies: The attention deficits of people with TBI decrease with time in the acute stage and with therapy in the chronic stage of recovery. The improvement appears to be limited to tasks similar to training tasks. Whether a focused or hierarchically structured

attention program will improve attention performance is uncertain.

Recommendation: No particular intervention aimed at improving attention performance in people with TBI has been supported unequivocally. However, attention performance has been shown to improve, and therefore, further research into the most effective intervention methods is warranted.

- **Memory**

Memory deficits are the most common cognitive impairment seen by occupational therapists (Blundon & Smits, 2000) and other rehabilitation professionals who care for patients with traumatic brain injury. Two meta-analyses were found, as well as six studies rated Level I, six rated Level II, six rated Level III, and one noncategorized (one group, posttest only) study.

1. UNIDISCIPLINARY COGNITIVE REHABILITATION

Ho and Bennett (1997; Level III) used a one-group pre-/posttest design to test the efficacy of a **cognitive rehabilitation program**. The program appears to have been designed and administered by neuropsychologists. The study had two goals: 1) Demonstrate that cognitive functioning, as measured by neuropsychological test scores, would improve following a specific program of remediational and compensatory therapies; and 2) Demonstrate that these improvements in neuropsychological scores would reflect improvements in activities of daily living (ADL). The treatment was individualized, but always consisted of two parts: formal cognitive remediation and training to compensate for cognitive deficits within everyday life settings. Frequency varied from 22 to 155 sessions and duration ranged from 5 to 82 weeks. All neuropsychological test scores improved significantly. Functional performance, as measured by modified *Acimovic-Keatley ADL* subtest scores as well as the total score, also improved significantly. The ADL test measured cognitive and behavioral processes related to activities of daily living; it did not measure actual occupational performance. There was no significant correlation between neuropsychological measures and ADL ratings. The authors concluded that cognitive rehabilitation that includes both remediation and compensatory strategies is effective. They further concluded that because there was no significant correlation between the neuropsychological test scores and the modified activities of daily living scale scores, the latter may measure aspects of cognitive functioning that are not the same as aspects of cognitive functioning reflected in neuropsychological test scores. There are several limitations:

- No control group
- Pretest data were obtained from records and, although not stated, this may be a retrospective, not prospective, study
- A timing bias may have existed because some participants were in treatment for 1½ years, during which procedures and therapists could have changed or spontaneous recovery could have occurred;
- The validity and reliability of the outcome measures were not reported
- Unlabeled numbers were reported for outcome; the exact probability levels were not reported, nor were the n's on which the statistics were calculated so no effect sizes could be calculated

2. MULTIDISCIPLINARY COGNITIVE REHABILITATION

Salazar, Warden, Schwab, Spector, Braverman, Waler, et al. (2000; Level I) used a two-group randomized trial over a 5-year period to evaluate the efficacy of **multidisciplinary inpatient cognitive rehabilitation** for patients with moderate to severe TBI. A group of 107 active duty military personnel with moderate to severe closed head injury participated in either an 8-week intensive standardized in-hospital cognitive rehabilitation program that included occupational therapy and other disciplines or an 8-week limited standardized home rehabilitation program with weekly telephone support, administered solely by a psychiatric nurse. At 1-year follow-up, there was no significant difference between Groups 1 and 2 in return to employment (90% vs. 94%), fitness for duty (73% vs. 66%), or employment (91% of the hospital group and 93% of the at-home group worked full-time). The authors concluded that the more costly in-hospital rehabilitation was no more effective than the limited at-home rehabilitation. One limitation of the study is that prestudy power analysis goals were not reached and poststudy power analysis indicated that the N (number) was 1/5 of that required to achieve significance. This limitation seems moot since the outcome percentages were so similar between groups. The patients were hospitalized at the time of recruitment; therefore, it appears that they were in the acute stage of recovery. If so, and because the measurements were taken 1 year after treatment, we cannot attribute the outcome to the intervention alone. Other explanations, such as spontaneous recovery, implicit learning, or experience, could account for the outcome. A no-treatment control group was needed to control for this.

Braverman, Spector, Warden, Wilson, Ellis, Bamdad, et al. (1999; Level III) used a one-group pre-/posttest design as part of a larger randomized controlled trial to describe the effects of **a multidisciplinary rehabilitation program** for moderately head injured active duty military service members. In this multidisciplinary program, occupational therapists (sometimes with the co-leadership of other professionals) led a cognitive skills group for 50 minutes 3 to 4 times week; a planning and organization group for 30 to 40 minutes 4 times a week; individual therapy for 50 minutes 1 to 2 times per week; work therapy 2 to 3 hours 4 days per week; a work skills group for 1 ½ hours once per week; and community reentry outings several hours per week. At the 1 year follow-up, 64 of the participants (95.5%) were able to work or were enrolled in college. Forty-four (66%) remained on active duty or were fit for duty, but were discharged from the military for nonmedical reasons. The authors concluded that the rehabilitation program demonstrates one successful effort to rehabilitate soldiers with TBI who have potential to return to duty. The study has limitations, however. Specifically, there was no control group; therefore, the outcome may have occurred for a reason other than the intervention, such as spontaneous recovery, implicit learning, or experience because the patients were in the acute stage of recovery (within 90 days of trauma) and the measurements were taken 1 year after treatment. These alternate explanations are plausible. There also was no statistical testing of outcome or operational definition or a description of reliability of the outcome measure.

Mills, Nedbeda, Katz, and Alexander (1992; Level III) used a one group pre-/posttest design to report functional outcomes of patients with TBI in a **structured community-based rehabilitation program** that emphasized improvement of the patient's real-life functional abilities (occupational performance) and psychological support. A **f**unctional rather than cognitive remediational approach was used. Treatment occurred 6 hours per day, 5 days a week for 6 weeks. Eight treatment goals were individually established by each patient and family with the team. The disciplines that made up the team were not identified. Outcome on each goal was rated on a 5-point scale from independent to dependent.

There was a significant improvement in functional evaluation after ($t_{30} = 4.67$, $p < .05$, $r = .65$). The average overall percentage of treatment goals achieved was 67.5% (range: 25%–93.7%). The majority of patients (n = 32) maintained or improved their overall status in the home (87.5%), community (87.5%), leisure (90%), and vocational function (90%) 6 months postdischarge. These gains continued to be maintained or improved at 12 months. The authors concluded that late treatment aimed at practical real-life goals, and not at specific cognitive deficits, accompanied by psychological support for patients and their families can lead to improved functioning and independence. They further stated that no demographic features, except low education, limited the potential success of this approach. In addition to the lack of control group and lack of detail, one limitation is that there may have been a memory bias regarding maintenance of goal performance because it was evaluated by interviewing the patient and family members, who had to remember immediate past performance.

3. MEMORY REHABILITATION

Loya (1999) did a meta-analysis of 14 studies (out of 117 retrieved) to determine the magnitude and efficacy of **memory rehabilitation** in moderate to severe TBI; to identify the most efficacious treatment strategies for improving postinjury memory functioning; and to identify moderating variables that facilitate the rehabilitation process. Loya categorized the interventions according to three emphases of cognitive rehabilitation: restorative (visualization, mnemonics); compensatory (internal mnemonics and external aids); and environmental adaptation. The author concluded that there was a significant, positive outcome resulting from memory rehabilitation among TBI survivors. However, homogeneity of effect size estimates prevented further analysis to rank order treatments by their effectiveness or to identify moderator variables. The author concluded that attribution of superiority of one intervention over another could not be justified on the basis of available research.

Cicerone, Mott, Azulay, and Friel (2004; Level II) used a two-group, pre-/posttest nonrandomized design to test the effectiveness of a program of **holistic, intensive, cognitive rehabilitation (ICRP)** administered by neuropsychologists on community reintegration as compared to conventional rehabilitation for people with TBI. The experimental program (ICRP) was administered by neuropsychologists 4 days per week, 5 hours per day, for 4 months. The control program, receiving standard rehabilitation (SRP), was administered by a physical therapist, an occupational therapist, a speech-language pathologist, and a neuropsychologist for 12 to 24 hours per week for 4 months. Both groups showed significant improvement on the *Community Integration Questionnaire*, with the ICRP group exhibiting a significant, but small, treatment effect compared to the SRP group (effect size, $\eta^2 = .10$). The SRP participants expressed significantly greater satisfaction with their community functioning on the *Quality of Community Integration Questionnaire* (nonstandardized) than did the ICRP group (effect size, $d = .57$). The authors concluded that intensive, holistic, cognitive rehabilitation (offered by neuropsychologists) is an effective form of rehabilitation, particularly for people with TBI who have previously been unable to resume community functioning. There is a threat to the validity of that conclusion because the SRP group was significantly more acutely injured than the ICRP group, raising the question of whether neuropsychological rehabilitation is effective or appropriate for people in the acute phase of recovery. The difference in the stage of recovery also affects the satisfaction with community reintegration, because those in the chronic stage would have more experience and therefore be more aware of their limitations. Intervention contamination may have occurred since both groups were treated in the same facility with no controls reported to prevent comparison of programs and sharing of experiences.

Freeman, Mittenberg, Dicowden, and Bat-ami (1992; Level II) used a two group pre-/posttest design to investigate the efficacy of memory retraining in patients with TBI using **executive and compensatory memory retraining strategies**. The experimental treatment consisted of read-aloud paragraph retention with techniques to enhance retention, such as note-taking in a memory notebook, self-monitoring skills, prompting from staff, restatement of presented material in the patient's own words, imagery, encouragement from others, asking for clarification, and specific feedback concerning success. The treatment group performed significantly better than the control (no treatment) group at posttest [*Paragraph Memory Task*] and the effect was strong ($t_{(10)} = 2.32$. $p = 0.02$, $r = .59$]. The authors concluded that the inclusion of memory retraining in cognitive remediation programs can improve memory function in patients with TBI. They further concluded that because the treatment group was in chronic stage of recovery, the significant recovery can be attributed to the treatment rather than spontaneous recovery. The study has a potential limitation in that the groups were referred for different reasons and could therefore have differed in some way, although they were not significantly different in IQ or memory deficit at the outset. The treatment group was also significantly more chronic than the control group (33 months vs. 12 months postinjury).

Quemada, Cespedes, Ezkerra, Ballesteros, Ibarra, and Urruticoechea (2003; Level III) used a one group pretest–posttest design to assess the effectiveness of a **memory rehabilitation program** on a heterogeneous sample of 12 patients with TBI. The program used Wilson's structured behavioral memory program, which includes behavioral compensation techniques and mnemonic strategies. It also included adaptations to reduce environmental demands (e.g., lines on floor, labels, painting doors different colors), external aids to help coding, storing and retrieving information (e.g., tape recorders, notebooks, diary schedules, maps), and reality orientation. Reorganization and restoration techniques were also used for 11 persons. Internal aids such as mnemonic strategies, and nonverbal strategies such as visualization and association were included in this program. Additional therapies were offered as needed to 10 persons, including social skills training and problem solving training. Treatment was individualized and administered daily in 50-minute sessions for 6 months, reduced to 3 times per week in the last month. After treatment, 9 patients were able to travel around their town without supervision. Six relearned how to use public transportation independently and regularly used it. Four redeveloped basic shopping and cooking skills. One patient learned to use the ATM; another to drive. In the 3 most severely affected patients, functional gain was limited to improvements in dressing, personal hygiene, and organizing their daily routines to require less supervision. However, there was no significant improvement on the *Rivermead Behavioural Memory Test*, the main outcome measure of the study. Neither patient nor family felt that memory had improved after treatment. Because the neuropsychological outcome measures did not indicate improvement, the authors concluded that research into the effectiveness of memory rehabilitation requires outcome measures that take independence in ADL into account. They stated that tests assessing memory processes tell us little about gains obtained in rehabilitation through the use of external aids or environmental modifications. The study has a serious limitation—the lack of a control group does not allow one to rule out spontaneous recovery as the explanation of the functional improvement because a majority of the participants were in the acute stage of recovery.

4. TEACHING METHODS

Kessels and de Haan (2003) did a meta-analysis on 11 studies (out of 27 retrieved) to investigate the effects of the **teaching methods of vanishing cues and errorless learning** as compared to trial-and-error learning in people with amnesia. The effect size for errorless learning compared to trial and error learning was 0.87 (large effect; $z = 2.42$, $p = 0.008$), whereas the effect size for vanishing cues compared to trial-and-error learning was 0.27 (small effect; $z = 0.38$, NS). The authors concluded that patients with amnesia benefit most from an errorless learning approach. The findings do not address the problem of generalization. They stated that the errorless learning principle is most effective in situations where implicit learning is possible (e. g., recovery of habits of self-care).

Tam and Man (2004; Level II) used a five group, pretest–posttest design to compare the effectiveness of four different **computer-assisted memory training strategies** based on the behavioral approach. Each program included four modules that were similar across programs and that related to important daily functions: remembering people's names and faces; remembering to do something; remembering what people say; and remembering where something was put. The teaching method differed, and included self-paced practice, visual presentation, multisensory feedback, and personalized training content. There was no significant improvement on the *Rivermead Behavioural Memory Test* by any of the groups. The feedback group showed a significant gain in self-efficacy score; no other group improved significantly. The authors concluded that using computers in patients' cognitive rehabilitation is effective, although the results do not uphold this conclusion. They further concluded that because the feedback group showed the greatest percentage of improvement of self-efficacy, feedback is a crucial factor to improve self-efficacy. However, the analysis was on the pretest to posttests of each group separately, not across groups to determine whether any one of the treatments is significantly better than another. Further limitations include repeated t-tests that were used without corrections and the control group being "chosen" while participants were randomly assigned to the four experimental groups.

Egan, Worrall and Oxenham (2005; Level III) used a one-group, pretest–posttest design to determine whether people with acquired cognitive-linguistic impairments following TBI could learn to use the Internet using **specialized training materials, which had been successfully tested with people with aphasia**. The materials were cast in a simplified format and used in conjunction with a volunteer, nonprofessional tutor. The four modules were taught over six lessons with the option of additional lessons. The modules incorporated 12 Internet tasks such as "turn on the computer," "save a site in favorites", and so on. The outcome was the ability of the participant to do each of the 12 tasks, each scored on a 5-point scale from total independence to not at all independent. For 6/7 participants, the Wilcoxon Signed-Rank Test showed significant gains in independence ($z = -2.201$, $p = 0.028$, $r = .78$). Participants achieved higher levels of independence in more concrete tasks that had fewer steps and required less abstract reasoning. The authors concluded that it is possible for people with TBI to reach moderate-to-high levels of independence in using the Internet with assistance of structured training materials. The materials designed for patients with aphasia did not need modification for use with persons with TBI. Severe cognitive-linguistic impairment (as seen in 1 participant) prevents participation in such a training program. In addition to lack of a control group, no information was given whether there was contamination of the independent variable by the participant or tutor outside of the research.

Parente and Stapleton (1999; Level III) used a two-group design in which the data for the baseline group were obtained from retrospective records. The two groups were unbalanced: The number in the experimental group was 13/33, while in the baseline group there were 64/568 who had been chosen to be comparable to the experimental group in age and education. The researchers investigated the effectiveness of a **Group Cognitive Skills Training Model (CSG)** as a precursor to vocational placement and reentry into the work world. The thinking skills training took place once per week for 2 months to 1 year (mean = 4 months). Ten out of 13 clients of the CSG group became employed full-time (rehabilitation rate of 76%). The rehabilitation rate for the baseline group was 58%. All employed CSG group clients were employed > 60 days; no data were provided for the baseline group. Grade point averages for those in the CSG group who went to school ranged from 2.5 to 3.5. The authors concluded that the best interpretation of the difference in rehabilitation rate (76% vs. 58%) is that the CSG experience facilitated a level of vocational rehabilitation that was unmatched by any other combination of available therapy services. Details of the methodology are lacking; therefore, discerning the study limitations is not possible.

Bergman (2000; level uncategorized) did an observational posttest only comparison of the effects of a **cognitive orthotic (CO)** and the ease with which a heterogeneous group of individuals with TBI demonstrated mastery when given the opportunity to try the CO. The orthoses made use of **errorless learning principles** and incorporated a very simple on-screen interface. Forty-one people more than 4 years postinjury participated. Thirty-six (88%) achieved mastery of 4 or more activity modules (e.g. journal, telephone log, directory, savings deposit/withdrawal, check writing, appointment scheduling) and therefore were considered successful users. The author concluded that the multifunction CO, with consistent, highly structured organization with integrated on-screen cues and feedback (error-free learning), promoted rapid, unassisted, reliable performance of targeted tasks and facilitated transfer of training across other activity tasks for most participants. The author stated that all learning occurred through active, self-directed use of the system rather than through directed instruction and repetition. The report lacks many details to allow judgment concerning the validity of the study; however, since there was no control group or condition and no pretest or pretreatment baseline, we can conclude that the evidence is weak.

5. COMPUTERIZED MEMORY ORTHOSES

Wright, Rogers, Hall, Wilson, Evans, Emslie, et al. (2001; Level II) used a one-group repeated measures, counterbalanced design to test whether a **computer interface** could be designed for memory aids on pocket computers, including an appointment diary and notebook that could be easily mastered by people with memory problems. The participants used two different handheld computer interfaces, for 1 month each with a 1 month washout period between. The researchers measured participants' attitude toward use of the computers and amount of usage of the two different computers. All participants could use the computers and 83% found them helpful. Amount of use varied widely. The only statistically reliable difference between the pocket computers was the greater use of alarms for diary entries when using the Hewlett-Packard ($t_{(11)} = 2.38$, $p < 0.04$, $r = .58$). The authors concluded that people with memory impairments resulting from brain injury can use purpose-designed computer-based memory aids, made of an appointment diary, notebooks, and links between them. They further concluded that the data strongly suggest that different pocket computers suit different participants. Wright, Rogers, Hall, Wilson, Evans, & Emslie (2001; Level II) also used a one-group repeated measures, counterbalanced design to examine the hypothesis that encouraging people to use a **pocket computer** more often for other activities, such as games, will increase the use of the memory

aids. They used the same interventions as in the first study, but added a memory aid to-do list and three games chosen to encourage planning and remembering. The first computer had Pairs, Hangman, and Mosaic games and the second computer had Crosswords, Solitaire, and Chess. Again, the researchers measured attitude toward use and amount of usage. All participants could use the computers and 83% (10/12) found them useful. The use of games did not correlate with computer usage as memory aid ($r = .11$). The authors concluded that people suffering from memory loss after brain injury can master purpose-designed electronic memory aids and find such aids of great personal benefit. Games were enjoyed by many participants but they did not increase the use of the memory aids. Both studies lack detail concerning possible threats to validity, for example, blinded evaluation, contamination, or cointervention. No standardized outcome measures with established reliability were used.

Wilson, Emslie, Quirk, and Evans (2001; Level I) used a randomized trial with crossover design to determine whether **a paging system** enabled people with prospective memory and planning problems after brain injury to carry out everyday tasks as compared to people with no pager. Although only 44% of the participants had brain injury due to trauma, this study was included because occupational therapists use paging systems as intervention and the study offered some evidence of paging system effectiveness. Approximately 8 messages were sent on the pager to remind each person to do some agreed-upon task at a given time. Group 1 used the pager in the home and community for 7 weeks, while Group 2 did not (wait list); Group 2 used the pager for the next 7 weeks and the first group did not. The outcome measure was individualized to each participant and consisted of 4 to 7 questions to determine whether the person had remembered to do targeted tasks. There was a significant difference in the number of targets achieved between those using the pager (~75%) and those not using it (~48% for those who had not used the pager at all and 62% for those who had used the pager in the previous 7 weeks). Almost 85% (84.6%) of participants were significantly more successful with the pager than at baseline. Of those in Group 1, 73% were still significantly better than baseline after the pager treatment was discontinued. The authors concluded that this particular paging system significantly reduces everyday failures of prospective memory and planning and enables people with brain injury to carry out more everyday tasks at relatively low cost. This conclusion is tempered by the fact that the outcome measure was a self-report and left to the patient to fill out daily, which could be a problem for people with memory disorders. There was no compliance or reliability information provided.

Hart, Hawkey, and Whyte (2002; Level I) used a one group repeated measures design with randomization to condition to test whether use of an **electronic device (a voice organizer; PDA)** could help clients with TBI to remember and articulate therapy goals (retrospective memory). Ten persons with moderate to severe TBI were randomly assigned to either a sequence of use of a PDA followed by no device or vice versa. In the experimental condition, the person was to listen to the list of goals on the device when it beeped (3 times per day); in the control condition, the participant was instructed to remember 3 goals of equal importance. The recorded goals were recalled significantly better than the unrecorded goals and a cued recall situation was significantly better than free recall for both conditions. The authors concluded that using a voice organizer to listen to recorded goals at multiple, consistent times each day was effective in enhancing recall of goals at the verbal level, with and without the addition of brief reminder cues. However, future research needs to evaluate whether this intervention affects actual goal-related behaviors.

Burke, Leeb, Hinman, Lupton, Burke, Schneider, et al. (2001; Level II) used a two condition, nonrandomized repeated measures design to test a tracking system for patients with TBI that couples the indoor fluorescent light fixture-based location system **("Talking Lights") with handheld computer technology** (called PLAM—patient locator and minder) to provide greater independence for these patients in their adherence to therapy schedules without staff prompting. The PLAM provided verbal cues that an appointment was coming up, directed the patient to start moving toward the correct room, and provided feedback about the accuracy of travel to the therapy destination. The control condition was the human prompting that is ordinarily used. The outcome measure was the number of human prompts needed and the on-time arrival at therapy destinations. Five persons with brain damage (60% TBI) used the PLAM. With the PLAM system, the average number of human prompts dropped more than 50%. The number of sessions requiring no prompting significantly increased from 7% to 44%. The on-time arrival increased significantly with the PLAM. The authors concluded that the results noting fewer (human) commands and greater punctuality imply that the constant reinforcement of external commands (whether human or mechanical) does facilitate learning and improved function. This conclusion overstates the data, however; they did not measure learning. The data stated that overall, this new technology has the potential to improve the lives of many individuals and thus move them toward greater independence. Limitations of this study include a difference in duration of the two conditions (experimental lasted 3 days and control lasted 1 week) and insufficient information about the methodology, including sampling procedure, outcome measurement, and statistical outcome.

6. NON-COMPUTERIZED MEMORY ORTHOSES

Watanabe, Black, Zafonte, Millis, and Mann (1998; Level I) used a randomized trial to examine the relationship among age, injury severity, and **use of calendar** on emergence from posttraumatic amnesia (PTA). Of the 32 participants with posttraumatic amnesia, only 50% were postTBI, but these were distributed equally between groups. This study was included because it researched an intervention commonly used by occupational therapists. In the rooms of the persons in the experimental group, a 8½ x 11 inch boldly printed calendar was visible to the patient and was brought to the patient's attention once a day if the patient answered incorrectly when quizzed about time orientation. In the rooms of the control patients there was no calendar. Treatment was discontinued when the patient was accurate for 2 consecutive days on the *Temporal Orientation Test* or was discharged. The difference between groups was not tested. Instead, the association between calendar use and emergence from PTA was tested and found to be $R = 0.03$, accounting for only 0.09% of the variance of emergence from PTA. The authors concluded that calendars may not be helpful in promoting reorientation despite their frequent espousal. However, this conclusion is subject to further research because this study was severely flawed; the most problematic threat to validity was possible contamination of the control group who probably received orientation information from other staff or visitors. In addition, measurement reliability and validity were not controlled, and too few participants emerged from PTA to allow the planned statistical analysis to be carried out.

7. TREATMENT INTENSITY

Paniak, Toller-Lobe, Durand, and Nagy (1998) and Paniak, Toller-Lobe, Reynolds, Melnyk, and Nagy (2000; both Level I), using a cohort of 119 persons with acute mild TBI (MTBI), studied the immediate (1998) and long-term (2000) effects of "**treatment as needed"** (TAN), operationally defined as a 3–4 hour neuropsychological and personality assessment and feedback, a consultation with a physical therapist, and further treatment as needed in addition to that received by the single session group, which is operationally defined as meeting with the

principal investigator to discuss any concerns about head injury and the contents of a brochure on minor head injury. There were no statistically significant differences between groups on the *Community Integration Questionnaire (CIQ*) in either study. Occupational status improved significantly over time in the 1998 study, but there was no difference between groups. There was no difference between groups in satisfaction with treatment scores. There was no decline in functioning between the 3- and 12-month evaluations (by telephone interview) in either group. The authors concluded that, when applied within 3 weeks of MTBI, a brief educational and reassurance-oriented intervention is just as effective and as highly patient rated as a potentially more intensive and expensive model. However, the independent variable (amount of therapy) may have been compromised (equalized between groups) because the TAN group reported a median of only 1 further treatment after the initial educational treatment. Another limitation of the study is that no information was given concerning ceiling effects on the CIQ, which are likely in this population.

The **conclusions** from these reports are:

- Memory rehabilitation is effective (Cicerone et al., 2004; Freeman et al., 1992; Loya, 1999) but, on the basis of available research, no intervention can be considered more effective than another (Loya. 1999).
- The evidence is not definitive regarding whether multidisciplinary (including occupational therapy) or unidisciplinary (e.g., neuropsychologists; psychiatric nurse) cognitive rehabilitation is more effective (Braverman et al., 1999; Cicerone et al., 2004; Salazar et al., 2000).
- Errorless learning is more effective than vanishing cues or trial-and-error methods of teaching patients with memory impairment after TBI, especially in situations where implicit learning is possible (habit recovery; Bergman, 2000; Kessels & de Haan, 2003).
- Computerized memory orthoses are effective in compensating for deficits of prospective memory (Burke et al., 2001; Wilson et al., 2001) and retrospective memory (Hart et al., 2002).
- Use of a calendar with only minimal orientation was not effective in orienting postTBI amnesic patients (Watanabe et al., 1998).
- Simplified computer interfaces and training materials facilitate mastery of computer use for persons with memory impairment (Bergman, 2000; Egan, Worrall & Oxenham, 2005; Wright et al., 2001).
- Using the computer to play games does not increase the usage of the computer for memory compensation (Wright et al., 2001).
- Neuropsychological measures do not correlate with ADL ratings (Ho & Bennett, 1997; Quemada et al., 2003).
- Treatment aimed at relearning functional tasks through task-specific training or by learning compensatory strategies for memory impairment appear to be effective (Ho & Bennett, 1997; Mills et al., 1992; Parente & Stapleton, 1999; Quemada et al., 2003), but the evidence is weak and needs further study.
- For persons with mild TBI, a single session of patient education and discussion of concerns was as adequate as a more intense treatment regime (Paniak et al., 1998, 2000).

Recommendations:

Although the evidence is sparse, it is recommended that treatment for memory impairment include goal-specific training in actual context, compensatory strategies, and environmental adaptations. It is further recommended that that occupational therapy researchers increase the pace of research into the effectiveness of occupational therapy interventions before this practice area becomes the claim of other rehabilitation professionals.

Summary of Levels IV and V

Because there are 25 studies at Levels I–III, and because evidence at Levels IV and V is weak in comparison, the Level IV–V studies are not summarized here, with the exception of the 4 reports by occupational therapists.

Ownsworth, Fleming, Desbois, Strong, and Kuipers (2006; Level IV) used a single case experimental design with multiple baselines across settings to study the effects of a 16-week program of **metacognitive contextual intervention with systematic feedback and family education** on 1 patient with very severe TBI. The intervention included systematic feedback to target error behavior while the patient performed functional tasks relating to his cooking and paid employment goals. During the 8-week treatment period in the cooking setting, there was a 44% reduction in error frequency. The average error frequency in the maintenance period indicated that the treatment effect was maintained. There was no spontaneous generalization to volunteer work. With specific training, error frequency in the work setting reduced 39%. There was no appreciable improvement in general awareness of deficits. Three weeks after the intervention, he gained paid employment with the use of a job coach (trained by the therapists) for 1 month. The authors concluded that the study provides preliminary support for a metacognitive contextual approach for enhancing self-correction and functional gains for an individual with awareness deficits, but further research is needed. A multiple baseline single-case design provides some weak support for acceptance of a causal relationship between the treatment and the reported outcome; however, in this case the baseline measure of errors in the cooking setting was descending without treatment; therefore, self-correction may have occurred as a result of practice, rather than the feedback intervention. This requires further study.

Landa-Gonzalez (2001; Level V), in a report of one case of a person with substantial memory and executive function impairments and poor insight about his functional limitations post TBI, examined a 6-month **multicontextual community reentry occupational therapy program** directed at awareness training and compensation for cognitive problems after TBI. Therapy included exploration and use of effective processing strategies, task gradations, and practice of functional activities in multiple, natural contexts. The program lasted for 6 months. The client's awareness level, occupational function, and satisfaction with performance improved while level of attendant care decreased. On the Kohlman Evaluation of Living Skills assessment, he needed assistance with 10 skills at baseline but only 3 at discharge (budgeting for food, budgeting monthly income, and use of phone and book). On the Canadian Occupational Performance Measure, he gained 1.5 to 2 points for each performance score and 1.5 to 3 points for each satisfaction score. After treatment, he predicted task performance more accurately and closer to his actual performance. Gains made in treatment were maintained 8 weeks after discharge. The author concluded that training and education using selected processing strategies facilitated improved awareness and occupational function. Case reports present interesting ideas, but cannot establish the intervention as the cause of change observed because there are no controls for threats to internal validity. The uniqueness of the subject precludes external validation or generalization to other patients. More controlled study is warranted.

Schwartz (1995; Level V) reported the outcome of three cases in which the author applied **decision-making and dynamical assessment models of occupational therapy practice**. One case did not involve TBI. In the other two cases, the goals were to increase initiation or independence in basic activities of daily living. After 3 months, Case #1 became independent in

daily tooth brushing and shaving. Two years after initiation of the tape-recorded messages, Case #2 followed his morning routine using only a checklist in the bathroom. He was unable to transfer these skills to a different context. The author concluded that occupational therapy provided external compensations that facilitated the learning of specific behavior routines for these patients with severe memory impairment and other cognitive deficits. The author further stated that in the long run, this could help reduce nursing or attendant care hours and thus health care costs. However, this report offers no trustworthy evidence that the interventions described caused the outcomes reported. The outcomes were very modest in light of the extent of therapy involved, therefore negating the statement concerning cost effectiveness.

Shimelman and Hinojosa (1995; Level IV) used a single subject ABA reversal design to examine the result of **gross motor activities** on the attention behavior of 3 adults with brain injury as measured by their performance on letter cancellation tasks. There is no theoretical support for this question; it is asked out of the experience of one of the authors. Visual inspection of graphs indicated no clear changes in trend or level of performance in the 3 phases of the study or in the 6 test tasks. The authors concluded that gross motor activities are ineffective in improving attention behavior as measured by pencil-and-paper tests.

The **conclusion** from these reports is that occupational therapists need to research the interventions they use to improve occupational performance of people with cognitive impairments post-TBI. At this point in time, we have weak evidence of Level IV and V studies that task-specific training within a multicontextual community reentry occupational therapy program may be effective in restoring occupational function to people with moderate to severe cognitive impairment.

Recommendation: These studies offer insufficient evidence to recommend for or against task-specific training within a multicontextual community reentry program for improving cognitive impairments post-TBI. It is strongly recommended, however, that occupational therapy researchers increase the pace of research into the effectiveness of these occupational therapy interventions before this practice area becomes the claim of other rehabilitation professionals.

Contributions of Qualitative Studies:

No studies using qualitative methodology were included in the literature search and review.

Bottom Line for Occupational Therapy Practice:

- Treatments that involve errorless relearning of previously known habitual activities; are carried out within real-life contexts; involve simple, direct instruction with feedback; and utilize extensive practice which occupational therapists and other professionals use for patients with cognitive deficits appear to be effective.
- Treatments that we consider “occupational therapy” are being delivered and documented in the literature as neuropsychological rehabilitation, speech-language therapy, and/or psychological intervention.
- At this time, there is insufficient evidence whether or not to recommend specific occupational therapy interventional practices for people with cognitive impairment following TBI.

Review Process:

Procedures for the selection and appraisal of articles

- Titles of all studies retrieved by online database searches using combinations of the key terms listed below were reviewed
- A total bibliography of 184 published articles resulted. Abstracts of those studies were retrieved and printed
- Based on the abstracts, 91 studies did not meet inclusion criteria and were deleted
- The remaining studies (N = 93) were retrieved either from the Boston University library system (Mugar Library, Science & Engineering Library, interlibrary loan, online sources) or the Wilma West Library of the American Occupational Therapy Foundation
- After detailed review, 34 further studies were found not to meet inclusion criteria and were deleted. Another 18 studies not reporting effects in terms of occupational performance, broadly defined to include everyday memory tasks such as developing a shopping list, etc., as well as areas of occupation, were eliminated
- Each of the remaining studies was analyzed and the evidence tables were completed; for this question, 41 studies were evaluated
- Of these 41 studies, 36 were done by psychologists, neuropsychologists, or speech-language pathologists using interventions that could be occupational therapy, but were described as cognitive rehabilitation or neuropsychological rehabilitation
- The 41 studies were classified according to the strength of their methodology and design. The 25 studies graded Levels I–III were included to portray the best evidence available at this time regarding interventions that address cognitive/perceptual impairments and their effects on occupational performance. In addition, 4 studies rated IV and V were included because they provide evidence specifically for occupational therapy interventions.

Inclusion Criteria:

- Published between 1990 and April, 2006
- Meta-analysis or systematic review
- Participants were persons with traumatic brain injury
- Participants were adults (> 18 years)
- Written in English
- The intervention must be current occupational therapy practice or theoretically could be occupational therapy practice.
- Outcome must be measured in terms of occupational performance.

Exclusion Criteria:

- Nonintervention studies such as prediction or correlational studies or longitudinal observational studies of natural history of recovery
- Theoretical, descriptive, or nonanalytical review papers
- Descriptions of programs or of treatments without testing effects
- Basic research
- Drug studies
- Outcome measured by neuropsychological test batteries only.

Search Strategy

Categories	Key Search Terms
Patient/Client Population	Brain injury; memory; attention, problem solving
Intervention	Occupational therapy; rehabilitation, cognitive therapy, task-specific training
Comparison	Critical reviews, meta-analyses, randomized control trial (RCT), randomized controlled study [other designs retrieved, but not sought through key search term]
Outcomes	Community, activities of daily living, leisure, return to work, participation

Databases and Sites Searched
PubMed (Medline)
OTSeeker.com
OTCATS.com
DARE (www.york.ac.uk/inst/crd)
Cochrane Collaboration (www.cochrane.org)
PsychINFO
CINAHL
Web of Science (Science Citation Index & Social Science Citation Index)
National Guidelines Clearinghouse (www.guidelines.gov)

Quality Control/Peer Review Process:

Only the author reviewed the studies. The studies were read twice; they were reviewed further if a question arose. This CAT has not been peer reviewed.

Results of Search

Summary of Study Designs of Articles Selected for Appraisal

Level of Evidence	Study Design/Methodology of Selected Articles	Number of Articles Selected
I	Systematic reviews, meta-analyses, randomized controlled trials	13 (3 meta-analyses)
II	Two groups, nonrandomized studies (e.g., cohort, case-control)	6
III	One group, nonrandomized (e.g., before and after, pretest–posttest)	6
IV	Descriptive studies that include analysis of outcomes (single subject design, case series)	9
V	Case reports and expert opinion, which include narrative literature reviews and consensus statements	6
	Qualitative Studies	0
	Uncategorized	1
		TOTAL = 41

Limitations of the Studies Appraised

Levels I, II, and III

The primary limitations of the studies graded Level I–III are:

1. Lack of control group or condition or comparison group for Level III studies, which limits the strength of evidence that the intervention caused the outcome.
2. Lack of detail concerning methodology to allow judgment of threats to internal validity of the study.
3. Lack of information concerning the validity and reliability of measurement.
4. Small sample size.
5. Although not a limitation to the internal validity of the studies, a practical limitation is the poor choice of outcome measures, for example, those that require patients with memory problems to recall behavior and those that measure the cognitive components of functional skills rather than ability to accomplish functional skills.

Levels IV and V

The four occupational therapy studies of these levels that are included in this appraisal have the common limitations of

1. Extremely small sample size
2. Lack of controls for ensuring internal validity of the study; therefore, no causal relationship can be established between the intervention and outcome based on these studies.

Articles Selected for Appraisal (Those marked with an asterisk * are included in this CAT)

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*Landa-Gonzales, B. (2001). Multicontextual occupational therapy intervention: A case study of traumatic brain injury. *Occupational Therapy International, 8,* 49–62

*Levine, B., Robertson, I. H., Clare, L., Carter, G., Hong, J., Wilson, B. A., et al. (2000). Rehabilitation of executive functioning: An experimental-clinical validation of Goal Management Training. *Journal of the International Neuropsychological Society, 6,* 299–312.

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This work is based on the evidence-based literature review completed by Catherine Trombly, ScD, OTR/L, FAOTA.

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