A Comprehensive Approach to Memory Rehabilitation Following Brain Injury

Michael J. Raymond
Kristin C. Bewick
Kit B. Malia
Thomas L. Bennett

Memory is not a unitary process, and it may be conceptualized in a number of ways depending on the type of information being consolidated or recalled. Regardless of the type of information to be stored in memory, it is widely accepted that the memory process involves four sequential, interrelated processes or stages, including:

1. Attending to the information;
2. Encoding, organizing, and maintaining the information in working (short-term) memory;
3. Consolidating or storing information into long-term memory;
4. Retrieving consolidated information as needed.

When an individual says, “I don’t remember,” it can reflect an impairment in one or more of these stages. For most individuals with mild to moderate brain injury, the disruption is typically demonstrated at either the attentional level, the retrieval level, or a combination of both. Individuals with severe brain injury are likely to also suffer working memory and/or consolidation deficits.

For most individuals with brain injury, pre-injury memories are retained and accessible, although possibly less efficiently, post-injury. However, the most common difficulties reported by brain injured individuals is that of adding new information to memory, and later, retrieving that information when needed.

It is important to differentiate between information learned before the brain injury and information learned after the brain injury. Retrograde amnesia refers to a loss of memory for events that occurred prior to the brain injury. In general, the more severe the injury, the more severe the retrograde amnesia, with events experienced years before the injury often being retained better than events experienced weeks or months just prior to the injury.

Post-traumatic amnesia refers to the period of time from the injury until the point at which ongoing memory for events becomes fairly stable or continuous (this includes time in coma). Duration of post-traumatic amnesia is typically a better predictor of long-term outcome than is duration of loss of consciousness. Finally, anterograde amnesia refers to difficulty remembering events that occurred after the brain injury, and as indicated, it is the most common memory problem observed in brain injured patients.

The construct of memory is subdivided further in the memory literature to include a distinction between declarative and procedural memory. Declarative (explicit) memory is defined as a memory for facts, events, and personal experiences, while procedural (implicit) memory deals more with learned motor skills and sequences which occur on a daily basis. Individuals with brain injury typically evidence greater difficulty recalling information related to declarative memory than to procedural memory.

Memory Functioning Following Brain Injury

Many studies report patients’ subjective complaints of memory difficulty after brain injury,
and these deficits appear to persist. In studies of subjects with severe brain injury, memory deficits were reported in 73% of cases at 3 months post-injury (McKinley, Brooks, Bond, Martineau & Marshall, 1981); 69% at 12 months (Brooks, Campsie, Symington, Beattie & McKinlay, 1986); 80% at 2.5 years (Thomsen, 1987); 67% at 5 years post-injury; 79% at 7 years (Oddy, Coughlan, Tyerman & Jenkins, 1985); and 75% at 10-15 years post-injury (Thomsen, 1987).

For many individuals with brain injury, forgetfulness can be a corollary of cognitive fatigue, reduced speed and efficiency of information processing, and/or attentional deficits. While the majority of individuals may report verbal/auditory memory problems, visual memory deficits may also be a common occurrence (Raymond, Bennett, Malia & Bewick, 1996). An experience or event cannot be consolidated unless it is appropriately attended to, processed, and encoded. For such individuals, forgetfulness improves as these underlying difficulties resolve. However, primary consolidation deficits, secondary to medial temporal lobe or diencephalic damage, do not resolve significantly with improvements in such basic processes as attention and concentration. These individuals can be left with permanent amnestic disorders whose impact can only be reduced by utilizing structured compensatory strategies (Bennett, 1991).

Medial temporal lobe structure (primarily the hippocampus) and diencephalic regions (hypothalamus and thalamus) are believed to be involved in the consolidation of declarative memory (Filley, 1995; Scoville & Milner, 1957; Squire & Moore, 1979). Memories are not stored in these structures. Rather, these structures perform a “pacemaker” function as part of a memory neural network. Information consolidation depends on synaptic change in the same cortical regions (sensory, motor, and association cortex) which originally participated in the learning process.

Individuals with a consolidation deficit due to hippocampal or diencephalic damage may have intact attentional capacity and working memory. These cognitive skills, which are components of the learning and memory process, are dependent on the frontal lobes. Interestingly, patients with frontal lobe injury can, in contrast, learn new declarative information but tend to fail on tasks dependent solely on working memory (Shimamura, Janowsky & Squire, 1991).

The neuroanatomical basis for retrograde amnesia is less clearly understood. Some clinical studies have suggested that damage to pathways in the anterior regions of the temporal lobes, sparing the hippocampus, may produce a retrograde memory deficit and leave anterograde memory intact. Similarly, the neuroanatomical basis of procedural memory has yet to be clarified. To date, clinical research conducted with persons having sustained basal ganglia injuries and individuals with Huntington’s Disease, suggests that the neural system underlying procedural memory involves the basal ganglia and frontal lobes (Bennett & Curiel, 1989; Butters, Wolfe, Marbone, Granholm & Cermak, 1985). Individuals with frontal lobe injuries also show increased susceptibility to interference from nonrelevant stimuli, and poor memory for temporal order and spatial information (Kolb & Whishaw, 1990).

**Assessment of Memory**

There are many tests available to assess learning and memory abilities in patients with traumatic brain injury. The Tactual Performance Test (TPT), from the Halstead Reitan Neuropsychological Test Battery (HRNTB; Reitan and Wolfson, 1985), provides a good measure of nonverbal learning and memory skills. The TPT Memory and Localization scores are indexes of incidental learning. Subtest 7 of the Adult Category Test is another nonverbal memory test within the HRNTB. Additionally, Benton’s Visual Retention Test provides information regarding visual-perceptual, constructional, and nonverbal learning and memory skills in brain injured people.

The Rivermead Behavioral Memory Test is a test of everyday verbal and nonverbal learning and memory skills. It uses analogies of everyday learning and memory tasks in a relatively nonstructured format. It appears to have good ecological validity in predicting memory problems in unstructured activities of daily living (Wilson, Cockburn, Baddeley & Hiorne, 1989).

The California Verbal Learning Test (CVLT) is a word list learning task similar to the Rey Auditory...
Verbal Learning Test (Delis, Kramer, Kaplan & Ober, 1987). The computer analyses and comparative norms available for the CVLT allow the examiner to make a detailed assessment of the patient’s strengths, weaknesses, and factors contributing to difficulties in verbal learning and memory abilities.

Reitan’s Story Memory and Figure Memory Tests continue to be widely used, and demographically adjusted norms are available to evaluate a patient’s verbal and nonverbal memory skills (Heaton, Grant & Mathews, 1991). A battery approach to assessing learning and memory skills is available through assessments such as the Wechsler Memory Scales-Revised (Wechsler, 1987) or Williams’ (1991) Memory Assessment Scales.

**Rehabilitation of Memory Deficits**

Rehabilitation approaches for memory deficits of brain injured patients may be remediation oriented or more compensatory in nature. Memory cannot be directly rehabilitated if it is the result of injury to the diencephalic-hippocampal system critical for consolidation of declarative memory (Bennett, 1991). Memory can, however, be indirectly remediated by improving an individual’s pacing, fatigue management, organizational skills, speed and efficiency of information processing, cognitive processing capacity, and attention abilities. This can be approached by direct education, the use of computerized cognitive rehabilitation programs such as Bracy’s PSS CogReHab-Version 95 or client-therapist paper and pencil activities such as those included in the Memory Module of BRAINWAVE-R: Cognitive Strategies and Techniques for Brain Injury Rehabilitation (Malia, Bewick, Raymond & Bennett, 1997).

A direct educational component is critical in whatever approach one uses in memory rehabilitation. Weber (1990) stresses the importance of feedback to help patients understand the nature of their problems, learning strategies to overcome the problems, and generalize their learning to meaningful everyday life situations.

Metacognitive training (Flavell, 1985) is increasingly recognized as essential components in the cognitive rehabilitation process (Ben-Yishay & Diller, 1993); Bewick, Raymond, Malia & Bennett, 1995). The Memory Module of BRAINWAVE-R has been designed to incorporate a strong metacognitive component, including: an educational component teaching the patient about how memory works and how to use strategies to improve memory functioning, study questions to test acquisition of knowledge, rating charts on which the patient predicts performance and rate actual performance, a performance summary sheet which allows therapist and patient to compare ratings in order to improve accuracy of prediction and self-evaluation, and ideas to stimulate the patient to determine the relevance and purpose behind each exercise.

**Efficacy of Rehabilitation for Memory Deficits**

Research has shown that repetitive practice and drills which focus on the direct restoration of memory have been essentially ineffective (Godfrey & Knight, 1985; Prigatano, Fordyce, Zeiner, Roueche, Schacter, Rich & Stampp, 1985), even after extensive training periods (e.g., 625 hours in the Prigatano et al. Study). The use of computerized techniques has also demonstrated limited efficacy when focusing solely on a restorative memory approach (Gianutsos, 1981; Gianutsos & Gianutsos, 1979). Thus, it is generally regarded that direct restoration/remediation of memory is not possible (Berg, Koning-Haanstra & Deelman, 1991; Wilson & Moffat, 1992). Therefore, memory rehabilitation efforts can be more effective when they aim to optimize residual abilities, teach compensatory strategies, and/or overcome other cognitive problems which may be contributing to the memory deficit (such as attention and concentration problems).

There have been a number of studies reporting positive results from internal strategy training, particularly for the use of visual imagery and the PQRST study technique (Boring, 1988; Cermak, 1975; Crosson & Buenning, 1984; Crovitz, 1979; Glasgow, Zeiss, Barrera & Lewinsohn, 1977; Malec & Questad, 1983; Molloy, Rand & Brown, 1984; Twum & Parente, 1994; Wilson, 1981; 1982; 1987). The latter technique, involving the stages of Previewing, Questioning, Reviewing, Stating, and Testing, encourages patients to process written tasks more effectively.
material more thoroughly. However, there is a lack of evidence to show the applicational uses of such strategies within real-life situations (Lawson & Rice, 1989).

Successful use of internal strategies in real-life situations relies on good use of cognitive skills (Sohlberg & Mateer, 1989), and it has therefore been suggested that the training of internal strategies can be of limited use for many patients with significant cognitive compromise (Baddeley, 1982; Butters & Cermak, 1980; Richardson & Barry, 1985; Schacter et al., 1985). This potential limitation in internal strategy training is supported by Wilson (1987) and Ryan and Ruff (1988) who report that improvements following internal strategy training are dependent upon injury severity. Levin (1992) stresses the need for further studies using appropriate control groups in order to allow more definitive conclusions about the efficacy of internal strategy training for the improvement of memory following brain injury. Unfortunately, design flaws in efficacy studies may limit the strength of conclusions about memory rehabilitation (Benedict, 1989), and it is apparent that studies have demonstrated mixed results (Fussey & Tyerman, 1983; Ryan & Ruff, 1988).

There are strong indications that memory strategy training combined with executive function training is more successful than isolated memory training (Freeman, Mittenberg, Dicowden & Bat-Ami, 1992; Lawson & Rice, 1989). Lawson and Rice reported maintenance of improvement at six month follow up, although gains were not shown to transfer to real-life situations. The executive strategy training in the study included task analysis, strategy selection and initiation, and monitoring of strategy use.

Sohlberg and Mateer (1989) report positive results from their training program to extend the amount of time an individual is able to successfully remember to do things (prospective memory). The fact that their treatments mirrored real-life situations was suggested as the major contributing factor to the success of this program. A recent study (Berg, Deelman & Koning-Haanstra, 1995), also indicated that it is possible to improve functional memory using training aimed at daily life situations. Training of this nature would include individualized treatment goals, strategy training, patient education, and teaching of strategies in real-life situations.

There are also positive reports for the use of memory notebooks (Fluharty & Priddy, 1993; Sohlberg & Mateer, 1989). However, patients often fail to use memory notebooks outside of therapy sessions (Sohlberg & Mateer, 1989). It has been suggested that this may be due to overestimation of cognitive abilities, failure to recognize the need for a memory book, and rejection of techniques that draw attention to deficits (see Fluharty & Priddy, 1993).

Conclusion

In summary, it would appear that memory rehabilitation is possible, although direct rehabilitation of memory deficits that are primary cannot occur. In those cases, the focus must be on patient awareness and the use of compensatory strategies. Fortunately, for most individuals, memory deficits are secondary to such factors as attention and encoding, and these problems can be directly remediated. Compensatory strategies can be used to help the person deal with any residuals. We recommend six phases in developing and implementing a rehabilitation program:

- **Phase 1.** Gather and review all pertinent medical records regarding the patient’s complaints of memory problems.
- **Phase 2.** Complete a detailed interview with the patient to determine what, when, how and why the specific memory problems occur.
- **Phase 3.** Complete a formal neuropsychological evaluation to determine the specific strengths and weaknesses related to memory skills.
- **Phase 4.** Select the most applicable memory strategies and the most applicable remediation exercises for the patient. These should include metacognitive components (e.g., self-monitoring and self-evaluation).
- **Phase 5.** Demonstrate the use of the strategies to the patient.
- **Phase 6.** Encourage the patient to use the strategies in real life situations.
Finally, but perhaps most important! The therapist should involve the family members or significant others in all phases of memory treatment in order to ensure strategy generalization into real life situations and demands. The inclusion of the family should be a priority, providing education about memory deficits, prognosis, implications of deficits, and suggestions for ways to enhance the memory remediation and compensation processes.

REFERENCES


