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Cognitive rehabilitation and traumatic brain injury

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Introduction

The last twenty years have seen a rapid expansion in the provision of post-acute rehabilitation services for patients with traumatic brain injuries (TBI) in North America, although such provision remains limited in Britain.[1] These developments have been precipitated by a growing appreciation by health purchasers and providers of the neuropsychological and social sequelae of TBI and demands by patients and their families for effective treatment. Most investigations have found that the majority of TBI survivors are young males under the age of thirty and that by far the most common cause of TBI is road traffic accidents.[2] Typically the frontal and temporal lobes of the brain suffer the greatest impact and survivors subsequently present with deficits affecting memory and new learning, attentional dysfunction and impaired planning and organizational skills.[2–4] Emotional and behavioural changes such as apathy, disinhibition and poor self-awareness may also be observed.[5,6] These cognitive, affective and behavioural changes have been found to represent the most important determinants of patients' ability to resume employment and social and leisure activities, as well as stress among family carers.[4,7,8] Moreover, follow-up investigations suggest that after severe head injury these problems follow a chronic course.[4,9,10]

Goals of cognitive rehabilitation

What are the goals of cognitive rehabilitation? Ponsford[11] and Wilson[12] drew attention to the World Health Organization's[13] distinction between impairments, disabilities and handicaps. Impairments can be physical (e.g. frontal lobe damage) or psychological (e.g. anterograde amnesia), whereas disabilities represent problems arising out of impairments such as being unable to recall conversations, names or whether one has passed on a message. Handicaps are problems attributable to society, such as poor educational or vocational support. Wilson[12] pointed out that although many clinicians involved in rehabilitation aim to treat cognitive impairments, for instance, by using exercises, the goal of rehabilitation should be to reduce disability and handicap, that is, problems in the patient's everyday routine. Wilson[12] suggested that cognitive rehabilitation focused on impairments is only useful inasmuch as this goal is achieved. This is similar to Woods'[14] suggestion that cognitive rehabilitation should improve patients' social adaptability. Sohlberg and Mateer[15] advocated the Process Specific Approach, which focuses on specific cognitive impairments such as attentional dysfunction, and utilizes hierarchically organized tasks which are administered repetitively to remediate the deficit. They proposed that the ultimate aim is to enhance independent living and vocational achievement (i.e. reduce disability). While it is increasingly recognized that rehabilitation should ameliorate disability rather than impairments alone, differences remain between those who suggest that impairment-oriented treatment may yield social effects,[15] and those who eschew treating underlying impairments and advocate interventions that focus directly on functional behaviours in the home and community.[11] A related distinction has been made between retraining and compensatory approaches to rehabilitation.[16,17] Retraining approaches seek to remediate damaged cognitive functions and tend to address impairments such as damaged memory or attentional systems. Contrastingly, compensatory approaches utilize strategies such as mnemonics or diaries to circumvent damaged functions rather than

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improve them. As such, compensatory treatments, particularly those involving the use of external aids, tend to be more concerned with minimizing disabilities.

Neuropsychological assessment: advantages and limitations

A clear understanding of the nature of a patient's cognitive strengths and weaknesses is arguably an essential requirement prior to commencing cognitive rehabilitation. The nature of these deficits varies according to a number of factors which include, but are not limited to, the site and severity of the trauma, time since the injury and the patient's premorbid cognitive status.[2,18] The clinician who wishes to assess these difficulties has no shortage of neuropsychological tests from which to choose.[18,19] However, many measures have limitations when used in rehabilitation settings as they were developed to assess cognitive impairments rather than disability. While tests may be useful in detecting cerebral dysfunction and lesion localization, it has been suggested that they may provide limited information on whether a patient is capable of working, living independently, or managing his or her finances.[20,21] A number of 'ecologically valid' tests such as the Rivermead Behavioural Memory Test,[22] the Test for Everyday Attention,[23] and the Behavioural Assessment of the Dysexecutive Syndrome,[24] have been designed to overcome these limitations and are more predictive of everyday functioning than traditional laboratory-type measures.[25–27] Whether it is realistic to expect neuropsychological tests to have strong predictive power, however, is debatable. For instance, the likelihood of a disabled TBI survivor returning to work depends on the complex interaction of a range of factors including not only the patient's cognitive deficits, but also his or her emotional and behavioural status, socio-economic class, local economic conditions, support structures at home and in the workplace and the particular requirements of the job, to name but a few.[28–30] Moreover, the relative importance of such factors will vary from one individual to another. In such circumstances, it may be unrealistic to expect that cognitive test data alone will be highly predictive of such outcomes, and at best they will provide useful information which, together with extra-test data derived from interviews, observation and relatives, help guide rehabilitation and clinicians' decision-making.

Cognitive retraining

As Gianutsos[31] put it, the goal of restoring damaged cognitive skills is a 'long shot,' not least because it questions the conventional view that the damaged nervous system cannot be repaired. Typically, retraining treatments involve the use of tasks or games which patients practice repetitively and through rehearsal it is assumed that cognitive skills are remediated. DeBoskey *et al*.[32] and Deaton[33] proposed that games such as Trivial Pursuit and Scrabble have a place in rehabilitation, as they engage a range of skills such as problem-solving, attention, visual discrimination, memory and sequencing, and provide the opportunity for enjoyable and varied practice. Similarly computer-assisted cognitive rehabilitation (CACR) invariably involves the repetitive administration of cognitive tasks and through 'drill and exercise' it is assumed that skills can be restored.[34,35] While these methods have been widely used and they continue to have their proponents,[32,33,36] there has been a growing scepticism as to their functional utility.[11,12] This can be illustrated in the case of the remediation of memory disorders, where it has been argued that drill and exercise methods cannot be expected to enhance psychological functions in the same manner as muscle strength is re-established through exercise.[37] While some have found that cognitive exercises bring about improvements in memory and attention which generalize to daily living,[36,38] others have suggested that appropriately controlled investigations are relatively few in number and those that are available provide little encouragement for the restorative approach.[37,39] In a number of studies Sohlberg and co-workers[40–42] have suggested that prospective memory (the ability to recall future events) may be amenable to remediation. Raskin and Sohlberg[42] pointed out that attempts at treating memory disorders have tended to neglect prospective recall, and they described two patients who underwent prospective memory training which involved repeating actions at future specified times. One subject's prospective memory span increased from one to five minutes, and that of the other improved from two to ten minutes. These gains appeared to generalize to the patients' everyday routine as indicated by the observations

of significant others. While Sohlberg's studies are encouraging, there is as yet insufficient evidence to suggest that prospective memory training represents an exception to the generally negative conclusions that have been drawn in this area.

Attempts to retrain attentional skills typically involve the administration of tasks which require attending to auditory or visual stimuli with or without distraction, letter or number cancellation or Stroop-type activities. The success of these treatments has been variable, with some studies showing improved attentional skills[43–46] and others demonstrating no significant gains.[47,48] Mateer and Mapou[46] drew attention to the difficulty in demonstrating that treatments generalize to everyday living and pointed out that many outcome measures resemble the therapy tasks. Novak *et al*.[49] proposed that the variability in outcome studies may arise from the non-specific nature of interventions. They suggested that hierarchically organized training, initially involving basic processes such as sustained and focused attention and progressing to higher level attentional skills, such as selective, alternating and divided attention (focused training), might be more effective than non-hierarchically ordered treatment (unfocused training). However, they found that two groups given focused and unfocused training improved equally. Sturm *et al*.[50] suggested that attentional retraining might be more effective when the treatment task is matched to specific attention deficits. They trained patients in two of four attentional domains (alertness, vigilance, selective, divided), in which they were most impaired, and found that improvement in a particular function only took place with specific training. Their results suggested that interventions particularly tailored to specific deficits might be more efficacious than general stimulation and rehearsal.

Gianutsos[31] suggested that even if remediation cannot be achieved, it may nevertheless be appropriate to provide such treatment on the grounds that it establishes a relationship with patients and so keeps them engaged in therapy. He proposed that exercises also provide the opportunity for the development of insight and that success on tasks develops feelings of competency. While this may well be so, there seems to be no reason to think that other (potentially more efficacious and cost-effective) treatments might not equally achieve these goals.

Compensatory rehabilitation

Compensatory interventions have mostly been applied to the field of memory rehabilitation where three kinds of strategy can be distinguished: internal, external and environmental. Internal approaches involve teaching amnesic patients to use mnemonic strategies such as rhymes, acronyms, rehearsal or visual imagery to acquire information.[37,51] For example, to learn face-name associations, patients may be taught to produce an unusual or complex visual image incorporating elements of the name to facilitate subsequent recall. There is now a substantial experimental literature which indicates that internal techniques, and visual imagery in particular, do aid learning.[37] Despite this, such approaches have not been widely adopted in clinical practice. Mnemonics place significant demands on patients' ability to initiate and adapt their use, which is difficult for many TBI survivors who typically have myriad impairments, particularly dysexecutive deficits, which undermine the likelihood of generalization. In addition, such strategies are often insufficiently flexible for routine use; for instance, there is necessarily a finite number of names that can be encoded using visual imagery or information that can be incorporated in rhymes. Mnemonics may also be less efficacious than external aids. Zencius *et al*.[52] compared the effectiveness of written rehearsal, verbal rehearsal, acronym formation and notebook logging and found the latter was the most effective. External aids include diaries, planners, calendars, noticeboards, and electronic devices, with diaries being the most widely used.[54] Sohlberg *et al*.[16] described a three-stage training procedure to train patients in diary use, involving awareness training, practice, and generalization training. This represents one of the most comprehensive programmes available, which has recently been further developed by Donaghy and Williams.[54] Wilson *et al*.[55,56] have suggested that the acquisition of new information and use of aids can be substantially improved if trial and error learning is avoided and an errorless learning strategy is adopted. In a series of experiments Wilson *et al*.[55] demonstrated that preventing or reducing the opportunity for errors during acquisition facilitated the learning of words, names, orientation and general knowledge, and the use of a memory aid.

Hersh and Treadgold[57] recently developed an

electronic aid called the NeuroPage which receives messages from a central transmitter and which can be used to cue the wearer to recall tasks or follow a routine. Evans *et al.*[58] found the NeuroPage successfully cued a brain-injured patient through a routine. Wilson *et al.*[59] evaluated NeuroPage and found that all the patients in their study reduced their everyday memory lapses. A further hand-held device which can be trained to recognize the patient's voice, called the aid Voice Organizer, has also recently been evaluated.[60] The user can dictate messages into the device and specify orally the time and day when it is to be replayed. An alerting bleep sounds when the message is due and it can be heard by pressing a button. Five patients were given two prospective memory tasks which involved recalling messages after a delay of nine hours and remembering to complete domestic chores after delays of between one and six days. Using the Voice Organizer, all subjects showed significant gains in performance on the message-passing task and all but one benefited on the domestic task measure.[60] Kim *et al.*[61] described a head-injured male patient who was given a palm-top computer to cue attendance at therapy sessions and requests for medication. Within one day of introducing the aid, the patient attended sessions punctually and without prompting and he requested his medication. The effectiveness of such aids is impressive, both in terms of the gains achieved and the effort involved for both the patient and therapist. Often memory notebooks take considerable time and effort to establish their use,[16,37] whereas gains with electronic aids can be demonstrated much more rapidly and without prolonged training.[60,61]

Environmental compensations are widely used in clinical practice although they have rarely been the subject of research evaluation. This is because they often consist of common-sense solutions to specific practical problems: drawers may be labelled, patients may be taught to use a microwave instead of a gas cooker, timers may be used to control electrical items, smoke alarms may be fitted. The focus of such changes is almost always some aspect of the patient's home, work or community environment, and as such they have the virtue of reducing disability.

Preparation, context, generalization

Survivors of TBI rarely present with circumscribed cognitive impairments; invariably they have an array of interacting cognitive limitations and emotional complaints, such as depression, suspiciousness and post-traumatic stress as well as social difficulties such as financial and family problems.[62–64] Such difficulties may affect whether cognitive rehabilitation is beneficial and the degree to which gains are maintained and generalize to everyday living.[65] The degree of patient preparation prior to the start of cognitive rehabilitation may determine its effectiveness. Loss of awareness has been found to have a particularly important impact on the success of rehabilitation as impaired insight (metacognition) may undermine patients' motivation to engage in treatment for deficits that are not recognized or seen as significant.[6,66,67] Chervinsky *et al.*[68] recently developed the first questionnaire to assess patients' motivation for post-acute rehabilitation and, following a factor analysis, four factors were extracted: Lack of Denial, Interest in Rehabilitation, Lack of Anger and Reliance on Professional Help. They suggested that the Denial scale represented the most important component of motivation for rehabilitation.

Sohlberg *et al.*[16] outlined a range of techniques to raise insight prior to starting training in the use of memory aids. These methods included providing educational material on the sequelae of TBI, using the Question and Answer method in which the patient learns the answers to a series of questions relating to his or her memory, and Structured Information Gathering, in which the patient collates information about his or her memory from a number of sources. Sohlberg *et al.*[16] suggested that in some cases it might be appropriate to expose the patient to controlled failure if he or she is resistant to these methods. Barco *et al.*[66] recommended a number of exercises to raise self-awareness including video feedback, self-ratings and practice at forward-planning. Unfortunately, while many of these methods have high face validity, their efficacy is largely unknown. Progress with many of the exercises developed by Sohlberg *et al.*[16] can be quantified and their effectiveness determined with the individual patient. Bergquist and Jacket[69] stressed the importance of goal-setting prior to rehabilitation as unrealistic, or irrelevant goals will undermine

treatment. They suggested that the therapist be supportive and non-directive when facilitating the identification of goals, so that the patient feels he or she owns them, with the effect that motivation is enhanced. Failure to agree goals may not always indicate impaired insight, but rather differences in priorities between the clinician and patient. If the clinician aspires to engage the patient in memory rehabilitation, perhaps because such a service is available, whereas the patient's ambition is to obtain a partner, the resulting mismatch will confound the intervention. Such a discrepancy may reveal more about the needs and limitations of the therapist than the patient.

The context within which cognitive rehabilitation takes place has increasingly been recognized as important in determining its success. Prigatano[70] advocated that neuropsychological rehabilitation address the full range of patients' difficulties and Wilson[12] proposed that cognitive rehabilitation should be holistic and include therapy focused on patients' emotional, interpersonal and social needs. Prigatano[70] suggested that neuropsychological rehabilitation should consist of five elements: cognitive rehabilitation, psychotherapy, a therapeutic milieu, a productive work trial, and family involvement. The importance of a therapeutic milieu to facilitate engagement in cognitive rehabilitation as well as the development of insight, has been emphasized by a number of researchers.[71,72] Prigatano[70] suggested that psychotherapy may be required, as cognitive rehabilitation can have emotional consequences, though this may not always be necessary if patients show spontaneous adjustments to their situation. Employment provides patients with the opportunity to learn about their cognitive and behavioural difficulties and social reintegration. Several researchers have also stressed the role of relatives in supporting cognitive rehabilitation and the need to address their problems.[70,73] Neuropsychological rehabilitation requires the clinician to utilize insights and treatments not only from neuropsychology and the cognitive sciences, but also learning theory and group and individual psychotherapy. Sohlberg and Raskin[74] pointed out that although the need to generalize training is well recognized, the discipline lacks coherent and comprehensive approaches to ensure that this occurs. They outlined a number of principles to guide clinicians, which include the need to plan for generalization from the start of treatment, the use of natural rewards to aid learning, training in settings similar to the patient's environment, and the provision of sufficient practice to establish a new skill. They also recommended the use of objective measures to determine whether new skills have improved daily functioning and provided several examples of how these principles could be used in attentional, memory and awareness training. Sohlberg *et al.*[16] described a number of exercises to facilitate the generalization of memory aid training and also outlined procedures for developing and monitoring the generalization of attentional retraining.[75]

Future directions in cognitive rehabilitation

While cognitive rehabilitation started with attempts to remediate specific disorders such as amnesia or attentional dysfunction largely in isolation, the rapid development of the discipline has seen a growing recognition of the need to deliver cognitive interventions as part of a comprehensive approach which also addresses emotional, social and family issues. While the field is still in its infancy, there is growing evidence to suggest that integrated post-acute programmes result in significant and worthwhile improvements in daily functioning.[72,76–80] Cope,[76] for example, examined the impact of rehabilitation on residential status, productivity and dependency (hours support per day). Rehabilitation resulted in an increase in residence at home, increased competitive activity and reduced supervision. Prigatano[80] found significant gains in paid and voluntary employment following neuropsychologically-oriented rehabilitation. Wood *et al.*[79] maintained that, following a community-based rehabilitation programme, patients attained higher levels of independence with significant resulting cost-savings. Cope[78] concluded that it is now difficult to argue that rehabilitation is ineffective or due to placebo factors. The placement of cognitive rehabilitation within comprehensive programmes has also been accompanied by a growing appreciation of the need to focus interventions on the management of disability related to everyday living, rather than underlying impairments. It seems likely that the most clinically and cost-effective interventions will prove to be those which continue this approach.

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