Introduction

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The field of neurological rehabilitation has shown rapid growth over the past few decades, but it has a long history. As pointed out in a historical review by Prigatano (1999), interest in the impact of neuronal injury and recovery was expressed as early as 1888 by John Hughlings-Jackson, who speculated on mechanisms of recovery from hemiplegia and wrote:

> Why do patients recover from hemiplegia when the loss of nerve tissue is permanent? . . . I should put down paralysis at the onset to the destruction effected, and attribute degrees of recovery to degrees of compensation; nervous arrangements near to those destroyed, having closely similar duties, come to serve, not as well, but, according to the degree of gravity of the lesion, next and next as well as those destroyed. (cited in Prigatano, 1999, pp. 6–7)

In 1938, Karl Lashley (cited in Prigatano, 1999, p. 11) acknowledged the multifactorial processes of recovery, stating that

> functional loss may be due to destruction of essential structures, to temporary pathological changes in the cells, to shock or diaschisis, to metabolic disturbances, or to lowered tonic activity. In each case, the mechanism of recovery will be different, and we rarely know, in any instance, to what extent these various factors have contributed to the symptoms.

Until the 1980s, most neuropsychological rehabilitation programs focused on language disorders. In the mid-1800s Paul Broca administered language re-

habilitation programs. This was followed by the influential work of Shepherd Franz. In 1905, Franz reportedly speculated that "new brain paths are opened in the reeducation process" and that "it is probable that the right side of the cerebrum takes part" in this process (cited in Boake, 2003, p. 13). Franz also used forelimb restraint as a means of improving motor performance in hemiparetic monkeys (Ogden & Franz, cited in Boake, 2003, p. 13), an approach advocated to this day.

During and after World War I, Kurt Goldstein established the first brain injury rehabilitation programs for brain-injured soldiers in Germany, which had facilities for psychological assessment and workshops for vocational retraining, using compensatory methods, and emphasizing the importance of observing functional performance. Goldstein (1942) was also the first to describe impairment of "abstract attitude" as a basis for inappropriate social behavior.

During World War II Alexander Romanovich Luria developed an approach to the study of higher cerebral functions, their recovery, and rehabilitation, based on his work with victims of missile wounds. This approach formed the foundation on which much of modern neuropsychology and neuropsychological rehabilitation has been built. In his texts *The Working Brain* and *Restoration of Function after Brain Injury*, Luria (1963, 1973) acknowledged the presence of functional systems mediating cognitive functions, components of which might be located in different brain regions. The manifestations of cerebral dysfunction would therefore differ according to which part of the functional system was disrupted by injury. Luria emphasized the importance of a detailed neuropsychological examination of the brain-injured person as a means of establishing the precise nature of the cognitive impairment. This, in turn, formed the basis of an individualized rehabilitation program. He advocated extensive practice as a means of retraining the impaired function in order to rebuild new habits. He also acknowledged the influence of a number of factors on the extent of recovery, including the nature of the lesion, most particularly its size and the presence of complications in the recovery process, the state of the brain before the injury, including the age of the brain, and the person's premorbid personality and coping style.

Despite these cogent insights, which remain relevant to today's practice of neurological rehabilitation, this field was slow to develop after World War II and remained more focused on the alleviation of physical disability. During the 1970s, however, there was a growing awareness of the needs of individuals with traumatic brain injury. Improved medical management following the example of pioneers such as Bryan Jennett and Graeme Teasdale from Glasgow, led to a growth in the number of survivors of traumatic brain injury, who were predominantly young adults. It became apparent that rehabilitation models developed for people with primarily physical disabilities did not meet the needs of individuals with brain injury. While physical disabilities were present for some, the more prominent and common impairments were psychological in nature: im-

pairments of attention, memory, reasoning, and other cognitive abilities; communication difficulties; changes in behavior and personality. There was frequently a perplexing lack of self-awareness of these changes, which, in turn, created severe stress among family members. The youth of this group meant they would be living with these difficulties for many years and faced failure to attain important developmental milestones such as completing study, establishing a vocation, and forming long-term personal and social relationships.

In an attempt to address the unique impairments of the survivor of brain injury, neuropsychologists began to apply their techniques to impairments other than aphasia and thus developed the field, which became known as cognitive rehabilitation. Cognitive impairments were identified via traditional neuropsychological assessment methods and broken down into their underlying components. Repeated practice was given on tasks exercising different components of the deficit, with the aim of restoring the impaired function.

The development of this new field of cognitive rehabilitation was led by pioneers such as Leonard Diller and Yehuda Ben-Yishay from New York University and Rusk Institute of Rehabilitation Medicine. One of Diller's major contributions was the scientific evaluation of the impact of various remedial strategies for visuospatial disorders in stroke patients, most notably retraining of scanning abilities in patients with unilateral spatial neglect (Diller et al., 1974). This was one of the first well-designed controlled evaluations of a cognitive intervention and it had a significant influence on the field.

Yehuda Ben-Yishay worked with victims of head trauma. In the early 1970s he had developed a treatment program in Israel for victims of missile wounds, and he developed this concept further at New York University (Ben-Yishay et al., 1978). In addition to cognitive retraining exercises, clients received psychotherapy and participated in a therapeutic community, designed to enhance self-awareness and self-esteem and acceptance of change, in addition to cognitive function. The group of clients and staff spent many hours interacting as a group, discussing and learning to accept the changes in themselves, while also rebuilding their self-confidence. Realizing the importance of motivation in the rehabilitation process, Ben-Yishay was the first to address one of the greatest challenges which still faces clinicians to this day. This approach has been further developed by George Prigatano at the Barrow Neurological Institute in Phoenix and others (Prigatano et al., 1986; Prigatano, 1999).

During the late 1970s and early 1980s there was a surge in the availability of computer software designed for the retraining of various cognitive abilities by neuropsychologists such as William Lynch, Odey Bracy, and Rosamund Gianutsos. This software began to be used routinely in rehabilitation units. Controlled research studies evaluating the impact of such interventions was scant, however. Toward the end of the 1980s a number of studies were conducted evaluating the impact of such interventions, the majority focusing on

attention. These studies which are reviewed in other chapters of this book have had mixed findings. Overall, there is evidence of improvement on tasks being trained and other tasks which are similar, but limited evidence of generalization to everyday life.

These early cognitive interventions were generally evaluated using neuropsychological measures, which were similar to the tasks used for training. During the 1980s there was realization of the need to evaluate outcome from a broader perspective. Since that time many measures have been developed and applied, although there has been little agreement and uniformity in the use of criteria or measures. Initially emphasis was placed on the measurement of disability using a range of activities of daily living scales. More recently, there has been a greater emphasis on evaluating the performance of different social roles, such as the ability to live independently; to pursue work, study, and/or recreational pursuits; and to form personal and social relationships, using measures such as the Craig Handicap Assessment and Reporting Technique (CHART), developed by Whiteneck, Charlifue, Gerhart, Overholser, and Richardson (1992), and the Community Integration Questionnaire (CIQ), developed by Willer, Ottenbacher, and Coade (1994). Outcome has been measured not only from the perspective of the therapist but also from that of the injured person and close others. There has been greater emphasis on investigating not just how well individuals are functioning but also how they and their close others are feeling, and how they perceive their quality of life. With these developments in outcome measurement, follow-up studies have identified a significant number of individuals who continue to experience many difficulties in their daily lives over many years after they leave the rehabilitation setting.

As a consequence, there has been a trend toward the development of community-based models of rehabilitation. Transitional living centers were established to provide *in vivo* training in living skills. More recently such programs are being conducted within the context of the home or workplace, with retraining or support services being supplied as needed to maximize independence. All these developments have been constrained by decreasing funding support, particularly in the United States. Hospital stays and entitlements to rehabilitation services have been significantly reduced in the last decade. They have also been influenced by the growing application of evidence-based medicine and what is perceived as a lack of scientific evidence regarding the efficacy of rehabilitative interventions. This has been largely due to methodological weaknesses in much of the research which has been conducted to date (Chesnut et al., 1999; Cicerone et al., 2000; Carney, Chestnut, Maynard, Mann, & Hefland, 1999).

Paralleling all this has been an enormous body of basic neurosciences research focusing on mechanisms of neuronal injury associated with traumatic brain injury, stroke, and a range of degenerative diseases and processes occurring following injury, largely through animal studies. There have been trials of

a number of pharmacological interventions. Mechanisms of neuronal regrowth, sprouting, and dendritic reorganization and factors that facilitate and hinder these processes have also been studied. Major developments include the isolation of trophic factors, which appear to enhance regrowth and reorganization, fetal transplants, and work with stem cells as potential mediators of neuronal regeneration. The influence of different environmental situations or inputs and their interaction with recovery mechanisms has also been vigorously explored. Cognitive neurosciences research has developed our understanding of the brain mechanisms that underpin a range of cognitive functions, an understanding that has developed significantly with the advent of functional neuroimaging techniques.

Unfortunately, however, these bodies of work in human rehabilitation, animal studies of mechanisms of injury and repair, and the development of the cognitive neurosciences have been conducted in parallel, with minimal communication between them. Relatively little rehabilitation research has been based on neurosciences research or even solid theoretical underpinnings. Indeed many rehabilitation therapists are not cognizant of research in these other areas, which has profound implications for their work. Although there are a number of texts that focus on either theories of neurological recovery of function or approaches to rehabilitation, relatively few books have successfully integrated the scientific evidence relating to impairment and recovery of specific cognitive and behavioral disorders with the clinical application of rehabilitative interventions in adults.

This book aims to bridge this gap. In the first chapter Bryan Kolb and Jan Cioe outline basic principles of neuronal organization that underpin relationships between the brain and behavior, the physiological events associated with brain damage, and the factors that affect neuronal change after injury. In the second chapter, Bryan Kolb explores mechanisms of recovery from neuronal injury, the potential for plasticity in the normal and injured brain, and factors that affect recovery, exploring the potential for interventions which might enhance recovery.

With this as background, Chapters 3–7 cover five core cognitive domains—nonspatial attention, memory, language, visuospatial attention, executive function and self-awareness. Chapter 8 focuses on disorders of behavior. Each is written by a specialist in that field, who has worked at both a theoretical or experimental and a clinical level with individuals with disorders in that domain. In these chapters an attempt has been made to discuss, within a theoretical framework, anatomical, biochemical, and/or physiological aspects of the function and the pathophysiological basis of impairments resulting form different forms of brain injury and to suggest or review remedial interventions in light of this framework. The final chapter discusses the application of information from each of these chapters to the rehabilitation of cognitive and behavioral disorders associated with the two most common causes of acquired neuro-

logical disability—traumatic brain injury and stroke. The book thus attempts to bridge the gap between basic neuroscience and clinical practice and will, ideally, be read by practitioners at both ends of the spectrum.

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