Diagnosis and Rehabilitation in Clinical Neuropsychology

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In recent years, human clinical neuropsychology has emerged as a separate subspecialty within clinical psychology. This volume presents a singularly useful synthesis of the research and clinical procedures of this important new field. Psychologists and other professionals interested in identifying, evaluating and rehabilitating the brain-injured patient will find this book particularly appropriate. It will also serve as an excellent text for graduate courses in neuropsychological evaluation and treatment, and as adjunctive reading for specialists in rehabilitation medicine, special education, speech pathology, physical and occupational therapy, and disability determination.

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To Ellenda

PREFACE

HUMAN CLINICAL NEUROPSYCHOLOGY has emerged in the last decade as one of the fastest growing subspecialties within clinical psychology. Interest in the area has been aroused by important research efforts demonstrating the utility of psychological testing in the diagnosis and assessment of brain injuries, as well as in the design and evaluation of rehabilitation programs for neurologically impaired clients.

The research relevant to clinical neuropsychology has taken several forms. One major approach has attempted a "behavioral mapping," relating behavioral functions to specific structures and pathways in the human brain. Researchers in this area have investigated the behavior of patients with well-defined brain lesions, associating these lesions with performance on numerous test procedures. Research on "split brain" individuals, whose right and left hemisphere have been separated by congenital error, injury, or surgical intervention, has added immeasurably to our knowledge about brain function.

A second major area of research has attempted to develop clinical tests and procedures that can reliably differentiate between brain-injured and neurologically intact individuals. A third line of research has attempted to develop batteries of tests and clinical procedures that cannot only diagnose the presence of brain injury but also identify such factors as the location, cause, and time of onset. Finally, some researchers have attempted to relate neuropsychological measures to the prognosis of an individual patient and to the design of rehabilitation programs that can maximally restore function to the impaired patient.

All of these areas are closely interrelated and of great importance to the clinical neuropsychologist, who needs to be familiar with each research area in order to most effectively provide clinical services to a neurologically impaired population. Unfortunately, there has yet to appear a unified review of the basic findings in each of these areas and their relationship to the clinical

process. Literature involved with the practical aspects of clinical neuropsychology has been especially rare.

The lack of a unified approach has limited the growth and effectiveness of clinical neuropsychology. Often, basic information is not available to practitioners involved in the assessment and treatment of brain-injured patients. Advances in one area of research may not be communicated to other researchers and to clinical practitioners. Often this occurs because there is a failure to appreciate the relevance of the information to other areas. The lack of a central source for basic information in the field has led to the inadequate training of many clinical psychologists working with the brain-injured patient in hospital and outpatient settings. All of these conditions have made it difficult for maximally effective services to be offered to a significant number of clients. This state of affairs has also hindered the interaction of neuropsychology with other professions treating and assessing the brain-injured patient.

This volume brings together the relevant research, clinical procedures, and decision-making rules used by the clinical neuropsychologist. It is intended to serve both the professional psychologist who wishes to increase his/her knowledge in this important area, the student first learning clinical neuropsychology, and the professional in other related fields. In order to achieve this goal, this book surveys the scientific research and theory forming the foundation of clinical neuropsychology. It also covers the major clinical tests, procedures, rules of inference, and neurological data relevant to diagnosis and assessment in neuropsychology. Finally, the use of neuropsychological test procedures, evaluations, and theory for the design and evaluation of rehabilitation programs are discussed.

The first two chapters cover the theories and research linking brain structures to overt behavior. These chapters include a historical review of the development of concepts of brain function, as well as a short introduction to the physiology of the brain to acquaint the reader with the terminology used in this book. Information for these sections has been drawn from physiological psychology, neuropsychology, neurology, physiolo-

gy, and anatomy. They are written so that the individual with little background in brain anatomy and physiology can follow the text with few problems.

Chapters 3 through 8 deal with clinical test procedures and the manner in which psychological testing may be used to identify a brain disorder, localize the area of a lesion, and identify the underlying neurological cause. In these chapters, the basic procedures and decision-making rules used by the neuropsychologist are presented. The ways in which neurological aspects of disorders interact with the neuropsychological test results are discussed. Chapter 7 demonstrates some of the differences and similarities in the diagnosis of children, as compared to adults. Chapter 8 illustrates the diagnostic process with the presentation of a number of actual cases.

The last two chapters identify the emotional, neurological, environmental, and neuropsychological factors that determine the recovery of a patient from brain injury. Chapter 9 details the use of neuropsychological evaluation in designing rehabilitation programs that maximally aid a patient's recovery. Chapter 10 presents a number of specific rehabilitation techniques used with neurological disorders. In each of the chapters, the emphasis is on the unique contribution that neuropsychology can make to the overall rehabilitation process.

The material in each chapter has been chosen for its utility and interest to the clinical neuropsychologist and other professionals in this area. As a result, a great deal of research, especially that involving complex physiological processes, has been largely ignored. It is recognized that the areas omitted may one day provide us with the keys to fully understanding the brain and behavior. At present, however, such research is of little clinical value. Similarly, clinical tests of little or limited proven utility have been only briefly mentioned or omitted altogether. In each case, the decisions made were in an attempt to make this volume a more practical and efficient source of information for the reader.

Clearly, one cannot become a clinical neuropsychologist simply by reading a book like this. There exist too many complicating

factors and too many clinical settings and problems for this volume to do full justice to all of them. However, it is hoped that the book will provide the information and procedures that will enable the professional or student to maximally benefit from contact with brain-injured patients and clinical neuropsychologists. It is also hoped that the book will provide the professional in an allied area the information necessary to use the neuropsychologist and neuropsychological results in a way that maximizes the treatment and other aid given the brain-injured client.

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Diagnosis and Rehabilitation in Clinical Neuropsychology

Chapter 1

THE DEVELOPMENT OF THEORIES OF BRAIN FUNCTION

THROUGHOUT HISTORY, there has been continual interest in the relationship of the brain to behavior. This interest has led to the formation of many theories of brain function. This chapter will present a short history of the development of thought on brain and behavior relationships, followed by sections on the major theories of brain function now existent.

Ancient Theories

As early as 3500 B.C., man had written on the relationship of the brain and behavior. Some evidence suggests that this relationship had been recognized as early as the Upper Paleolithic period (Chapman and Wolff, 1959). By 500 B.C., Pythagoras had identified the brain as the site of human reasoning.

Hippocrates (circa 400 B.C.) believed that the brain controlled the senses and movement. He was the first person to recognize that paralysis occurred on the side of the body opposite the side of a head injury. Herophilus of Chalcedon (300 B.C.) and Erasistratur (280 B.C.) theorized that the ventricular cavities of the brain were responsible for mental abilities and movement.

Galen (131-201 A.D.), the first experimental physiologist and physician, identified many major brain structures. Galen felt that the frontal lobes were the seat of the soul. Early Christian scholars disagreed with this idea, locating mental abilities in the ventricles. The views of these Christian scholars, led by St. Augustine, were predominant in the Western world for nearly 1000 years (Chapman and Wolff, 1959), although Arabic physicians carried on the work of Galen.

During the thirteenth century, scientists began to break away from the ventricular theory. For example, Albertus Magnus theorized that behavior was the result of a combination of structures, including the frontal lobes, midbrain, cerebellum, and ventricles.

By the seventeenth century, investigators were looking for a single cerebral organ as the site of mental processes (Luria, 1966). Descartes theorized that mental processes were located in the *pineal gland.* He reasoned that, since the pineal gland was in the center of the brain, it was the logical area for mental abilities to reside. Willis, in 1664, located mental faculties in the *corpus striatum,* a structure deep within the cerebral hemispheres. Vieussens theorized that mental faculties were in the white matter of the cerebral hemispheres. Lancisi chose the *corpus callosum,* a band of fibers which join the left and right cerebral hemispheres, as the seat of mental functions (Luria, 1966).

Localizationist Theory

It was not until the nineteenth century that current views on brain function began to evolve. Early in the century, Gall (1758-1828) postulated that the brain consisted of a number of separate organs. Each organ, he felt, was responsible for a basic psychological trait, such as "courage" or "wit." Gall attempted to describe differences in individuals by differences in the size of individual brain areas (Krech, 1962). Since Gall's localizations of psychological abilities rested on speculation rather than evidence, most scientists of the time rejected Gall's theories.

Despite their rejection by the scientific community, Gall's theories were very popular with the public. This resulted in the development of the "science" of phrenology. Phrenology involved, in its most popular form, the reading of cranial bumps to ascertain which of the cerebral areas were largest. This was based on the erroneous concept that the brain area under a bump was larger than other brain areas. Once it was inferred which areas of the brain were larger, predictions were made about a subject's abilities and personality.

Scientific evidence supporting a localizationist position was not available until 1861, when Paul Broca announced that motor speech was located in the left posterior frontal lobe. Broca presented two clinical cases to support his contention. Both had fairly extensive injuries, lesions in the left posterior frontal lobe, and motor speech deficits. Broca's announcement, hailed by

many as a major breakthrough, led to numerous investigations into the localization of higher cognitive functions.

Wernicke (1874, reprinted 1970) announced a decade later that the understanding of speech was located in the posterior temporal lobe, although he did not indicate in which hemisphere (Wilkins and Brody, 1970). Wernicke noted that this loss of speech understanding was not accompanied by any motor deficit; only the ability to understand speech was disrupted (Geschwind, 1967).

Many other studies confirming a localizationist theory also appeared. Fritsch and Hitzig (1870) found that the major sensory and motor strips were located on either side of the central sulcus separating the parietal and frontal lobes. Kliessmaul in 1877 localized *word blindness,* an inability to read words, in the posterior left brain; others localized such functions as ideation, writing, and memory (Luria, 1966). By the mid-twentieth century, several maps had been published localizing both complex and basic psychological functions in separate parts of the brain (Kleist, 1933; Luria, 1966; Nielsen, 1946). Kleist's (1934) map indicates specific areas for such functions as reading, writing, walking, and memory.

Equipotential Theory

Many scientists found the localizationist theories unacceptable. They observed that the localizationists were unable to explain findings reported by numerous physicians: Lesions in widely disparate parts of the brain were reported to destroy such skills as writing. The localizationists said these skills were controlled by a circumscribed part of the brain. Moreover, patients with lesions in a particular area were still able to carry out a skill that had been assigned exclusively to that area.

Flourens, in the 1840s, was the foremost early advocate of an alternative to localizationist theories (Krech, 1962). Through an extensive number of experiments, logical arguments, and sometimes even practical jokes, Flourens attempted to disprove Gall's localizationist theories. In order to prove his beliefs, Flourens developed the *ablation experiment,* removing parts of the brains

of pigeons and hens. He reported that excision of any part of the brain in these birds leads to generalized disorders of behavior. From his experiments, he reached three general conclusions: (1) sensory input at an elementary level is localized, but the process of perception involves the whole brain; (2) loss of function is dependent on the extent of damage, not on the location; and (3) all cerebral material is equipotential (Krech, 1962). By *equipotential*, Flourens meant that if sufficient cortical material is intact, the remaining material will take over the functions of any missing brain tissue.

Flourens, however, can be criticized on a number of different points. First, he used animals with brains so small that any ablation would invade more than one functional area. Second, he observed only motor behavior, whereas the localizationists were interested in faculties such as friendship or intellect (Krech, 1962). Despite these scientific problems, Flourens was accepted by many as having disproved localizationist theory.

However, as the work of Broca and others became known, the scientific community came to accept a localizationist approach (Luria, 1966). Consequently, little was done to support Flourens' work until the early 1900s. At this time, the equipotentialists began to again develop evidence and research to support their theory. Marie (1906) examined the preserved brain of one of the patients Broca had used to support his hypothesis of localization. Marie found that the patient had widespread damage. Marie attacked Broca's theory, indicating that the patient could not speak because the extensive lesion had caused a general loss of intellect, rather than a specific inability to speak.

Other researchers soon expressed support for the equipotentialist position (Goldstein, 1927, 1944, 1948; Gooddy, 1956; Gooddy and Reinhold, 1954; Head, 1926; Monakow, 1914). In general, these researchers held that, while basic sensorimotor functions may be localized in the brain, higher cortical processes were too complex to be confined to any one area. Head (1926) indicated that symbolic functions were mediated by the brain as a whole. He also discussed the role of the brain as a whole in