The NEUROPSYCHOLOGY Handbook

Behavioral and Clinical Perspectives

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Human Neuropsychology: An Overview*

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HISTORICAL CONTEXT

Ebbinghaus stated a hundred years ago that "psychology has a long past but a short history." The same could be said of neuropsychology. Although its history can be traced to the Greeks, it was not until the last half of this century that the discipline became organized and widely accepted.

Euroasian Contributions

The earliest written records of attempts to localize neural function are dated between 2500 and 3000 B.C. (Walsh, 1978). These records contain descriptions of 48 case histories involving brain trauma. In more recent history, individuals such as Andreas Vesalius (1514–1564) began to analyze neural anatomy and function more systematically. Nevertheless, it was Rene Descartes (1569–1650) who is credited with first popularizing the notion of mind–body dualism, as well as the localization of function. The localization of the "seat of the soul" to the centrally located, single pineal gland remains classic. Continuing the French tradition, Paul Broca (1824–1880) followed the progress of an aphasic placed under his care at the Bicetre, an asylum near Paris. By meticulous observation and an eventual autopsy in 1874, Broca was

*Dr. Horton's contribution to this chapter was made in his capacity as a private citizen and without support or endorsement by the Veterans Administration.

able to conclude that aphasia was neither a loss of memory nor a muscular dysfunction. Instead, loss of speech could be directly attributed to trauma (in this case, a tumor) to the base of the third frontal convolution of the left cerebral hemisphere.

Pierre Flourens (1794–1867), a powerful opponent of the phrenology movement as espoused by Gall and Spurzheim, could be considered a forerunner to modern experimental neuropsychology. By developing ablation (i.e., lesion) techniques, Flourens proposed one of the first viable nonlocalization theories of brain functioning. During the twentieth century numerous neuropsychologists have contributed to the development of the field in Europe. Most notable of this group is Kurt Goldstein (1878–1965), who evaluated the effects of missile wounds in soldiers and military veterans in Germany. Using the case history approach popular with European neuropsychologists, the Russian A. R. Luria (1902–1977) systematically observed and interacted with numerous brain-injured individuals prior to formulating a functional theory of brain functioning. Luria cogently argued for the importance of individual brain systems in the organization of complex psychological activity.

North American Contributions

Although the development of neuropsychology has a more time-limited tradition in North America, the field has benefited from the contributions of numerous eminent psychologists. One of the first to contribute significantly was Karl Lashley (1890–1958), who performed numerous ablation studies (mainly of the visual cortex) while at the University of Minnesota, the University of Chicago, and Harvard. In contrast to the localization theories of the day, Lashley proposed the radical concept of equipotentiality of neural structures. Roger Sperry, associated with California Technological University, pioneered the split-brain studies in humans. In these studies, Sperry and colleagues (most notably Gazzaniga) examined the hemispheric function of individuals who had undergone a commissurotomy. In 1982, Sperry was recognized for his pioneering efforts in brain research by being awarded the Nobel Prize.

Applied neuropsychology in North America is often traced to Ward Halstead who, while at the University of Chicago Medical School, administered psychometric tests to individuals with frontal lobe damage. His results, the basis of his theory of biological intelligence, suggest that damage to the frontal lobes results in general reduction of adaptive abilities. One of Halstead's students, Ralph Reitan, was instrumental in furthering Halstead's concepts and translating these ideas into a psychometric battery of tests still widely used today. Hartlage and Telzrow (1982) recently reported the results of a survey of 158 neuropsychologists, who indicated that Reitan ranks as the individual who has made the most significant contribution to the field of clinical neuropsychology since 1940. The entire Reitan battery (e.g., the Halstead–

Reitan Neuropsychological Battery) was reported to be the fourth most frequently used neuropsychological assessment tool by this sample. Many other living neuropsychologists, too numerous to mention, are continuing to make significant contributions to the field and shaping the course of its history.

CONCEPTUALIZING HUMAN NEUROPSYCHOLOGY

In pursuit of conceptual clarity, the following brief definitions are provided. The terms to be discussed have been used in idiosyncratic fashion by numerous authors. This practice has undoubtedly diminished the conceptual clarity of the issues. To date, satisfactory methods of correcting this situation have not been developed.

Neuropsychology Defined

While different authors have advanced multiple definitions of neuropsychology, in the context of this chapter the following definition was selected: "Neuropsychology is the scientific study of brain-behavior relationships" (Meier, 1974).

Some limitations of this definition will be noted. It fails adequately to address the many fields of neuropsychology that have developed over the years (Davison, 1974; Horton, Wedding, & Phay, 1981). Also, the collateral areas of speech pathology and physiological psychology could easily have been included in this definition, although they will not be addressed (Meier, 1974). In order to provide further clarification, the following section will offer a brief survey of some selected subfields of neuropsychology: clinical neuropsychology, experimental neuropsychology, behavioral neurology, and behavioral neuropsychology.

Clinical neuropsychology is the "application of our understanding of human brain-behavior relationships to clinical problems" (Horton, Wedding, & Phay, 1981, p. 59). Similar to the development of the clinical psychologist as a professional psychologist with special psychometric and psychotherapeutic expertise in the general area of psychopathology, the clinical neuropsychologist is a professional psychologist with diagnostic skills and psychometric expertise applicable to behavioral dysfunction associated with central nervous system dysfunction. Just as carefully validated and rigorously standardized psychometric instruments such as the Wechsler Intelligence Scales (WAIS, WAIS-R, etc.) and Minnesota Multiphasic Personality Inventory (MMPI) are strongly associated with clinical psychology, the Halstead–Reitan Neuropsychology Battery and Luria–Nebraska Neuropsychology Battery are identified with clinical neuropsychology. The emphasis on psychometrics is in large part the result of the contribution of Ralph M. Reitan.

Experimental neuropsychology is the "elucidation of basic brain-behavior

relationships" (Horton, Wedding, & Phay, 1981, p. 59). Like experimental psychology, experimental neuropsychology has a primary focus on theoretical questions rather than practical applications. Due to the nature of the questions most often addressed, experimental neuropsychologists often use nonhuman subjects. The degree of generality of basic neurobehavioral relationships depends upon the species and area of psychology under study. For example, since the higher cortical function of language only achieves its full expression in human beings, it is difficult to conceptualize a truly appropriate nonhuman model for study (see Terrace, Petitto, Sanders, & Bever, 1979, for further elucidation on this issue).

Behavioral neurology is the third subfield of neuropsychology. Like clinical neuropsychology, behavioral neurology is concerned with clinical applications of scientific knowledge. However, unlike clinical neuropsychology, behavioral neurology utilizes a qualitative, intuitive approach; by contrast, clinical neuropsychology is seen as more psychometric and quantitatively based. Moreover, behavioral neurology utilizes a more traditional medical case study approach, such as that espoused by A. R. Luria (1973), to the conceptualization of neurobehavioral phenomena. This approach, of course, assumes that the practitioner has considerable clinical expertise as well as a thorough understanding of neural structure and function.

Behavioral neuropsychology is a recent addition to the principal subfields of neuropsychology. Horton (1979) has offered the following definition of behavioral neuropsychology:

> Essentially, behavioral neuropsychology may be defined as the application of behavior therapy techniques to problems of organically impaired individuals while using a neuropsychological assessment and intervention perspective. This treatment philosophy asserts that inclusion of data from neuropsychological assessment strategies would be helpful in the formulation of hypotheses regarding antecedent conditions (external or internal) for observed phenomena of psychopathology. (p. 20)

This new area of research and clinical interest combines segments of both neuropsychology and behavior therapy. Despite a focus upon applied aspects of neuropsychology, behavioral neuropsychology may be easily discriminated from these related subfields of neuropsychology by its reliance upon behavior therapy research for its treatment techniques. The major emphasis of behavioral neuropsychology is upon the problems of management, retraining, and rehabilitation. In contrast, the subfields of clinical neuropsychology and behavioral neurology are both strongly associated with the problems of differential diagnosis. Furthermore, it should be clear that experimental neuropsychology can be easily separated from clinical neuropsychology, behavioral neurology, and behavioral neuropsychology by the "pure" research aims of the former and the more clinical focus of the latter.

Examinations of some trends in behavioral therapy can help delineate the scope of behavioral neuropsychology. Behavior therapy can be seen as having developed three salient trends. These are, in order of importance, behavioral, cognitive, and affective. Based on the work of Watson (1913), Skinner (1938), and others, behavior therapy is based upon the principle that behavior is a function of consequences and utilizes reinforcement as a major concept. In contrast, the cognitive trend in behavior therapy is of more recent vintage (Mahoney, 1974). The cognitive trend postulates that inferred variables, such as thoughts and images, should be seen as legitimate concepts in the functional analysis of human behavior (Mahoney, 1974). The cognitive trend in behavior therapy has been a subject of continuing controversy (Beck & Mahoney, 1979; Ellis, 1979; Lazarus, 1979; Wolpe, 1978).

The affective trend in behavior therapy has a most curious history. Some would date these trends from the early work of Joseph Wolpe, M.D. (1978), the South African psychiatrist who is credited with the establishment of clinical behavior therapy. His techniques of systematic desensitization and assertiveness training have, in large part, sparked the clinical behavior therapy movement. Despite Wolpe's contribution, the affective nature of his work has remained unappreciated. More recently, however, there have been indications of increasing interest in affect by behavior therapists.

Brain Damage/Cerebral Dysfunction

A critical starting point in this volume would be to distinguish the terms *brain damage* and *cerebral dysfunction*. As is well known, a brain lesion is a pathological alteration of brain tissue. In almost all cases neurodiagnostic methods can identify these incidences of structural change brain lesions. However, classification of changes in brain physiology that are not reflected in structural modification is a more complex issue. For example, an open head injury caused by a gunshot wound clearly results in structural brain damage; yet obvious structural brain changes caused by toxic conditions would escape verification by many neurobiomedical diagnostic procedures (Horton & Wedding, 1984). Sometimes the term *cerebral dysfunction* is preferred to describe situations in which functional changes are clear, but the issue of structural changes is not yet clarified.

Organicity

In the context of addressing the proper usage of *brain damage* and *cerebral dysfunction*, some comments regarding the term *organicity* are appropriate. Davison (1974) has suggested the following:

> The concept includes the assumption that any and all kinds of brain damage lead to similar behavioral effects, and that behavioral differences among the brain damaged are due primarily to severity of damage and to premorbid personality characteristics. (p. 14)

Historically, the concept had roots in the equipotentiality/localization debate and is perhaps most associated, at least in the United States, with Karl Lashley (1929). As observed by Horton and Wedding (1984):

> . . . to understand brain damage as existing on a single dimension is as realistic and useful as the assertion that human beings vary on the dimension of height. To be sure, the assertion is true in a general sense, and, in special situations, could be quite useful (e.g. college basketball) but in many circumstances there could be a need for additional data with regard to sources of variation. (p. 12)

Despite the limitations of the concept of organicity, it has developed as a two-category (organic vs. functional) diagnostic paradigm for decades. The only positive development has been a clear trend toward the differentiation of the concept of organicity into various subtypes.

DSM III Categories of Organic Mental Disorders

With the development of the *Diagnostic and Statistical Manual* (DSM) by the American Psychiatric Association in 1962 came the growing acceptance by the mental health community and insurance industry of the need for diagnostic systems. The DSM has, of course, been subjected to critical review and extensive revisions (first in 1966 and, most recently, under the direction of Robert Spitzer in 1980). Regardless of the psychological community's skepticism and continued search for alternative diagnostic systems (cf. Miller, Bergstrom, Cross, & Grube, 1981; Smith & Kraft, 1983), the DSM-III continues to be the most widely used diagnostic system for clinical and research activities in North America.

Organic brain syndromes (OBS) were relatively easy to diagnose with the early versions of the DSM. Basic distinctions were predicated essentially on whether the syndrome was acute or chronic, thus resulting in only two major diagnostic categories. In the DSM II classification was accomplished with the variable of psychosis. The primary symptoms associated with OBS, according to the DSM II, were impairment of orientation, memory, intellectual functions, judgment, and affect.

The DSM III provides a more extensive array of classifications. Significantly different from the DSM II, the most recent version makes a clear distinction between syndrome and etiology. Organic syndromes refer to the resulting behavior without regard to the etiology, while organic mental disorder (OMD) directly reflects an etiology of brain dysfunction. The most common syndromes listed include delirium, dementia, intoxication, and withdrawal. The DSM III allows the development of a diagnosis according to either symptomology or etiology. If the etiology is known, then it should be used to diagnose. Otherwise, one simply focuses on the syndrome.

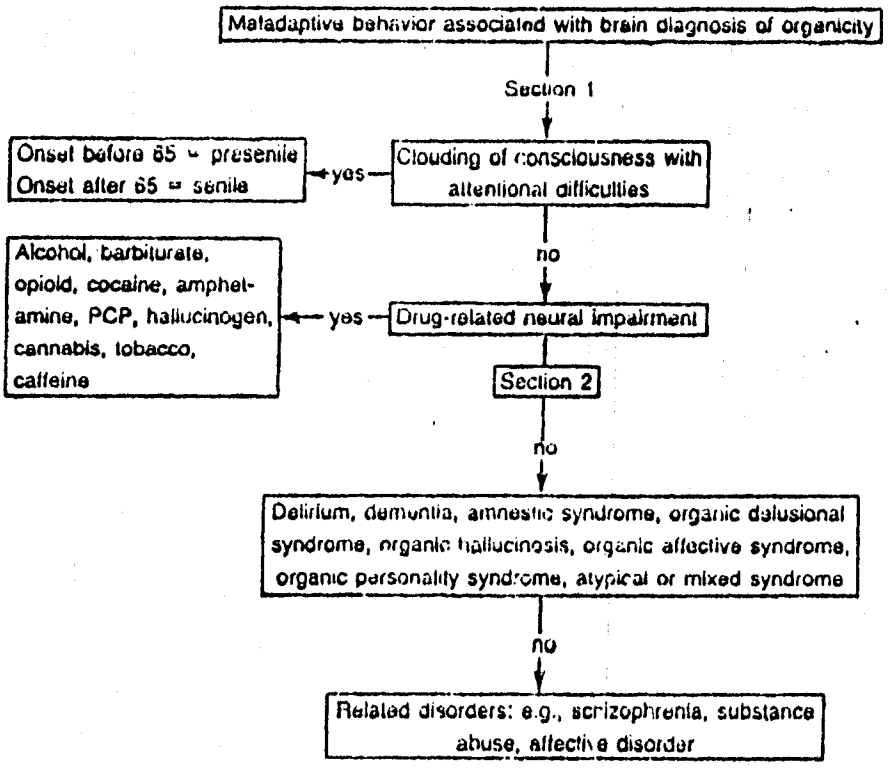

FIGURE 1.1 A basic decision tree for the differential diagnosis of organic mental disorders according to the DSM III.

As Figure 1.1 indicates, the most recent version of the DSM is divided into two sections based on whether the behavior or etiology of the behavior is found in the mental disorder section of the World Health Organization's *International Classification of Diseases—Ninth Revision—Clinical Modification* (ICD-9-CM, 1978). The largest number of diagnoses fall under section 1, those behaviors or etiologies listed in the ICD-9-CM. This section is subdivided into two main categories. First, dementia covers disorders related to "a loss of intellectual abilities of sufficient severity to interfere with social or occupational functioning." Dementias develop (1) prior to the age of 65, presenile, (2) after the age of 65, senile, or (3) because of an infarct (i.e., necrosis due to circulatory obstruction). Secondly, a category exists for substance use disorders that affect central nervous system functioning.

Section 2 contains diagnoses for which syndromes or etiologies are not noted in the prenatal disorder section of ICD-9-CM or are unknown. Additionally, this section is often used when the syndrome's etiology is directly traceable to a physical disorder already listed in Axis III of the diagnosis. The main diagnoses are delirium and dementia.

HUMAN NEUROPSYCHOLOGY AND TRADITIONAL MEDICAL SPECIALTIES

Like other fields of psychology, neuropsychology is related to and often confused with medical disciplines. A strong working relationship and an understanding of these related disciplines are critical to the development of neuropsychology as a science and as a profession. The confusion between neuropsychology and these disciplines arises from a misunderstanding of the training and scope of these medical specialties. This misunderstanding can, in large part, be attributed to the limited understanding of neuropsychology by the general medical community (cf. Anchor, 1983).

Neurology

The historical view of psychology, in general, and neuropsychology, in particular, traditionally held by neurologists is similar to that outlined by Greenberg (1983): while the brain is involved with behavior, it is not the source of behavior. This appears to have been especially true for higher-order behaviors. As a consequence, a specialist in the science of behavior could only offer limited contributions to the care of the neurologically impaired patient.

This limited perspective is rapidly vanishing as inroads are being made between these closely related professions. Indeed, it is not uncommon for psychologists to have clinical appointments in departments or clinics of neurology. This development has occurred in part as a function of the need for expert opinion on issues of behavior related to central nervous system functioning, especially higher cortical functions. This has become critical during the last several decades since neurology has moved away from its original (and once inseparable) partner, psychiatry. Strub and Black (1982) suggest that neurology has shifted its emphasis to the peripheral nervous system effectively, ignoring behavioral abnormalities. As neurology continues to deemphasize complex central nervous system behaviors, the neuropsychologist will continue playing a critical role for the neurologist.

Neurosurgery

Although the neuropsychologist is basically interested in the quantification, description, and remediation of behavior associated with brain damage, an implicit interest has been the anatomical localization of behavioral dysfunction. The current state of empirical knowledge indicates that while numerous advances have been made in the psychometric localization, further investigation needs to be performed with well-documented cases before acceptable levels of confidence can be attained in this endeavor. Until then, it is critical that the neuropsychologist work closely with neurosurgeons and neuroradiologists in an effort to develop more sophisticated tests and scales for cerebral localization.

From the standpoint of service to the neurosurgeon, a neuropsychologist can provide valuable assistance in the documentation of psychological dysfunction due to neural impairment (Freeman, 1981). Specifically, neuropsychologists can provide documentation of behavioral deficits both presurgery and postsurgery as a means to (a) determine changes linked to surgical intervention, (b) chart the course of neural dysfunction over time (e.g., tumor growth), (c) arrive at a prognosis of behavioral deficiencies, and (d) evaluate the risks and benefits to be derived from surgical intervention. Often overlooked by both disciplines is the role of the neuropsychologist in the rehabilitative process. Considering the invasive, nonpersonal nature of surgery, coupled with the limitations of the neurosurgeon in nonsurgical rehabilitation, behavioral neuropsychology plays an important role in the recovery process. Beyond dealing with primary issues resulting from the actual neural impairment, the neuropsychologist can assist in dealing with the secondary symptoms (e.g., depression, surgical recuperation, treatment compliance) as well as with family issues (e.g., readjustment, support) (see Chapter 12). Finally, an emerging role of the neuropsychologist within neurosurgery is the assessment and treatment of pain.

Psychiatry

One of the most important roles of the neuropsychologist in psychiatry has been the differential diagnosis of organic and functional disorders and of the existence of neural impairment in functional disorders (cf. Puente, Heidelberg-Sanders, & Lund, 1982; Ross & Rush, 1981). Considering that the psychiatrist is inevitably interested in behavioral dysfunction, the neuropsychologist comes as close as any professional to being able to provide pertinent information in the diagnosis and treatment of the neurologically impaired patient. There are several areas that warrant attention, including psychiatric manifestation of neural impairment and psychiatric basis for neural impairment. Of increasing importance to the psychiatrist working with neuroleptics is the assessment of neurobehavioral functioning associated with drug metabolism.

Behavioral intervention with brain-damaged individuals manifesting a combination of neural and behavioral deficiencies (e.g., dementia) is an area in which the neuropsychologist can effectively collaborate with the psychiatrist. This is especially important when the neuropsychologist has training in a particular subspecialty such as vocational retraining.

Rehabilitation Medicine

Although rehabilitation medicine has only recently been linked to neuropsychology, analysis of the function and purpose of this medical specialty provides suggestions for interaction. The primary function of the specialist in rehabilitation medicine is to help the patient return to normal functioning after an illness or injury. While this function seemingly suggests dealing with a

wide variety of physical problems, the specialty has tended to focus on chronic diseases. The two diseases that have received considerable attention have been movement and cardiovascular disorders. In the former, the neuropsychologist can assist in diagnosing and following the course of treatment for general motor dysfunction, including fine motor control. In the latter, the neuropsychologist provides differential diagnosis of stroke and related disorders and functional problems.

The neuropsychologist can play a significant role in relating neurobehavioral findings to the prediction of vocational performance. A problem that has long been neglected by neuropsychologists is the determination of disability in workmen's compensation and Social Security cases (Puente, 1982; Puente, in press).

HUMAN NEUROPSYCHOLOGY AND SELECTED NONMEDICAL SPECIALTIES

In this section, attention will be devoted to four nonmedical specialties: clinical psychology, health psychology, educational evaluation, and vocational evaluation. It is of course acknowledged that other nonmedical specialties could have been selected for discussion. Unfortunately, space limitation dictated that difficult choices had to be made and, in the opinion of the authors, the nonmedical specialties selected were most relevant to the practice and study of neuropsychology at present.

Clinical Psychology

Just as clinical psychology emerged from the interface of psychology with psychiatry, clinical neuropsychology emerged from the interface of psychology and neurology. That is to say, the particular problems that were encountered by psychiatrists in clinical practice were often those posed to the clinical psychologist. To a degree, the assessment devices that evolved and prospered in clinical psychology were devoted to diagnostic issues of vital importance to psychiatrists. For example, the Rorschach, Thematic Apperception Test, Wechsler Intelligence Scales, Minnesota Multiphasic Personality Inventory, and Bender–Gestalt Test are perhaps a classical selection (Lubin, Wallis, & Paine, 1971). As a battery these tests had both positive and negative consequences. On the positive side, the tests did an admirable job of selecting appropriate candidates for psychoanalytic therapy. Since for many years the majority of psychiatrists have been analytically oriented, the provision of a valid and reliable prediction of a patient's likelihood to engage profitably in this type of therapy was clearly of great value (Horton & Wedding, 1984).

On the negative side, the emphasis on suitability for psychoanalytic psychotherapy had deleterious effects on the development of comprehensive

assessment procedures for other varieties of patients such as the brain damaged. In simple terms, brain-damaged or "organic" patients were *not* seen as appropriate for individual analytically oriented therapy; they were identified as a class to be excluded without careful attention to relevant parameters or conceptual paradigms to explain facets of brain injury.

Health Psychology

Formal definitions aside (Stone, Cohen, & Adler, 1979), one might construct a working definition of health psychology as "psychology applied to medical complications and specialties." Within this working definition one sees that neuropsychology emerges as the branch of psychology that attends to the problems of neurology.

To be sure, all health psychologists are not neuropsychologists. Conversely, the proposition that all neuropsychologists are health psychologists is one that will engender spirited debate. If one accepts the aforementioned definition of health psychology as psychology (science and professional knowledge and skills) applied to medical specialties (including public health as a medical specialty), then the conclusion evolves that health psychology encompasses neuropsychology.

It is, of course, acknowledged that such a conclusion is not endorsed by all, but still the conclusion raises some crucial points. For example, a major focus in health care is cost containment and medical care utilization. At present the implications of such issues for neuropsychology are relatively unexamined. Similarly, more attention to the emerging paradigm of psychosocial intervention by health psychologists in the realm of medical specialties, such as cardiology, pediatrics, and oncology, would yield a different perspective on the role of the neuropsychologist. Moreover, recent data on neuropsychological sequelae of medical conditions not previously thought to produce neurological deficits (Ryan et al., 1984) are demonstrating some robust potential for the health/neuropsychology interface.

Education

One of the first to suggest that neuropsychological knowledge would be helpful in understanding childhood learning disorders was William Gaddes (1968). Many have advocated such a position (Hynd & Obrzut, 1981; Rourke, 1975); indeed, some have gone so far as to suggest that the interface of education and human neuropsychology has been so productive that a subdiscipline has evolved. Various terms advocated to describe this new subdiscipline have included *school neuropsychology* (Hynd & Obrzut, 1981), *developmental neuropsychology* (van der Vlugt, 1979), and *educational neuropsychology* (Gaddes, 1981). Factors which have contributed to the current enthusiasm regarding the educational relevance of neuropsychological

data include the wealth of reliable clinical findings correlating localized brain lesions and academic performance.

Of even more immediate value to the notion of promoting an interface between education and human neuropsychology has been research demonstrating the value of neuropsychological data in treatment planning for educational deficiencies. Perhaps some of the most interesting results were obtained by Hartlage (1975). In this early study, first-grade children were placed in reading programs based upon neuropsychological assessment data. The experimental group was 1.5 standard deviations above the control group in reading after one year. Similar results have been obtained by others (Kaufman & Kaufman, 1983). It should be noted that these studies utilized a strengths approach to treatment planning (Reynolds, 1981). Expectations are that a strengths approach will be of great value and that more effective use of behavior modification techniques can be made with this approach (Horton et al., 1981).

Vocational Evaluation

Although the evaluation of neural impairment by neuropsychologists is becoming increasingly accepted, the evaluation of vocational performance in brain-damaged individuals by the neuropsychologist remains a relatively little-explored professional and academic pursuit. Dennerll, Rodin, Gonzales, Schwartz, and Lin (1969) were among the first to investigate employed brain-damaged individuals. In a later study (Schwartz, Dennerll, & Lin, 1966), the use of prediction models for this population was reported. Similarly, Heaton, Chelune, and Lehman (1978) found significant differences between employed and nonemployed patients referred for neuropsychological evaluations. Employed referrals performed significantly better on a variety of neuropsychological tests. In a more recent effort, Cole and Long (in press) reported the relationship between neuropsychological and vocational performance in neurologically-impaired patients. These findings suggest that a high degree of correlation exists between both types of assessment. The authors conclude that duplication of services in the evaluation of neurological patients frequently occurs, indirectly giving greater credence to psychometrically-oriented evaluation. For a more complete review of the literature, the reader is referred to Heaton and Pendleton (1981).

Until recently, little scientific evidence had been reported to support clinical practice in the disability evaluation of brain impairment cases. Nevertheless, the importance of adequate evaluation and prediction for individuals with brain damage takes on an urgent nature in light of the August 1982 report by the Subcommittee on the Oversight of Government Management. This report indicated that while 75% of all disability determination reviews use at least one consultative exam, 68% of these consultations were deemed "not useful" by state disability determination services. Anecdotal evidence also suggests that state agencies are being required to give greater weight to these examina-

tions for reasons of accountability. It is assumed that neuropsychological evaluations of proven worth for determining vocational ability would be most helpful in this regard.

EMERGING TRENDS IN HUMAN NEUROPSYCHOLOGY

As observed by Costa (1983), it is a commonly held assumption that human beings demonstrate an ability to utilize the past and make projections of the future in order to govern present behavior. Thus, some speculations are offered regarding the possible future direction in which human neuropsychology will evolve in the coming years. The areas considered include education, clinical training, certification, new concepts, new technology, and new populations.

Education and Training

To a large extent, the recent history of education and training in human neuropsychology has been dominated by Manfred J. Meier of the University of Minnesota Medical School. Dr. Meier, through his writings (1981a) and his chairmanship of the International Neuropsychology Society Task Force on education, accreditation, and credentialing (1981b), has profoundly influenced events relative to the education and training of neuropsychologists. The task force outlined four models for education and training for neuropsychologists. Essentially, Model I casts neuropsychology as a subspecialty area in a traditionally applied curriculum. At a slightly more advanced level, Model II posits an interdisciplinary program between a department of psychology and a medical school. Model III is a Boulder Model scientific/practitioner, while Model IV is a combined scientific Ph.D. and professional Psy.D. program that requires a minimum of six years of training.

In terms of the future, one can anticipate a progressive increase of Model II programs, which currently exist in only a few universities. At present only a single university offers a Ph.D. in neuropsychology that follows the Boulder scientific/practitioner Model. One wonders if, rather than Model IV (Ph.D./Psy.D. programs), one might be more likely to see professional Psy.D. programs in neuropsychology. In terms of political and economic realities, it is likely that strong preexisting applied programs will not be the most fertile ground for neuropsychology programs and that very few students will have the financial resources to complete the six or more years of graduate work deemed necessary to pursue a combined Ph.D./Psy.D. program.

Certification

At present, the clinical practice of neuropsychology falls under the generic licensure umbrella of psychology in the United States and Canada. While the aforementioned International Neuropsychology Society Task Force on education, accredition, and credentialing promulgated specific criteria for the clini-

cal practice of neuropsychology, these guidelines are without the force of law. In the past, neuropsychological practice has been based largely on a measure of self-identification. In response to this situation, two diplomate-level granting boards have arisen to identify skilled practitioners of neuropsychology. The American Board of Clinical Neuropsychology (ABCN) is comprised largely of current International Neuropsychology Society members and has recently become affiliated with the American Board of Professional Psychology (ABPP). In contrast, the American Board of Professional Neuropsychology (ABPN) is comprised largely of individuals who are members of both the International Neuropsychology Society and the National Academy of Neuropsychologists. While some efforts have been made to combine these boards, at present both are operating separately. There is speculation that as more individuals are credentialed at the diplomate level, laws will be modified to restrict the practice of neuropsychology to designated individuals.

A related but separate development of importance is the concurrent development by the American Psychological Association (APA) of specific criteria for the recognition of new professional psychological specialties other than the traditional ones (i.e., clinical, counseling, school and industrial/organizational). New standards will be developed by APA relative to the practice of new specialties.

RECENT DEVELOPMENTS

New Concepts

Subcortical Brain Damage

Historically, high-order functions delineated by the cerebral cortex have been emphasized by the neuropsychologist to the exclusion of the examination of subcortical integrity. Considering the relatively large volume of noncortical area, the complexity of the behavior that it regulates, and the number of common neural disorders with subcortical origins, the importance of the subcortex should not be minimized. As a consequence, there is no substitute for a thorough understanding of subcortical anatomy and function.

Numerous behavioral changes are regularly observed as a function of subcortical damage. Typical subcortical damage often involves sensory systems, most notably the visual and auditory systems. However, the lower brain stem, as well as thalamic lesions, may affect pain and temperature sensations (Soffine, Feldman, & Bender, 1968). Disruption of extensive motor pathways, originating in the cortex and extending to the spinal cord via the basal ganglia and midbrain, may lead to either fine or gross motor disturbance. Generally, basal ganglia dysfunction produces problems with slower and more precise skilled movements, while lesions of the lower structures affect faster and more automatic movements such as posturing (Brodal, 1969). Limbic and basal

ganglia structures have also been experimentally implicated in learning. Specifically, lesions of these areas result in overresponsiveness and an inability to learn behavioral tasks or to generalize learned behavior (Ellen & Powell, 1962). Recall of learned information appears to be regulated by many of the same structures as learning (Barbizet, 1963; Ojemann, 1966). While limbic nuclei have historically been implicated in the regulation of affective behavior (Papez, 1937), in some cases damage to this area may result in increases in reactivity or in placidity, depending on the location of the lesion. Of the numerous structures associated with the limbic system, hypothalamic damage appears to play an important role in producing significant and permanent increases in emotional reactivity (Flynn, 1967). The role of cognition has typically been delegated to the frontal lobe. However, there is recent evidence to suggest that perceptual and cognitive behaviors, such as hallucinations and delusions, are directly linked to subcortical structure dysfunction (Fredrickson & Richelson, 1979).

In summary, numerous important behaviors often observed in neuropsychological settings are mediated by subcortical structures. One might consider the concept of subcortical brain damage as a new, emerging trend within neuropsychology; note, however, that the average date of the references included in this brief section is 1964. Clearly, research in subcortical behavioral pathology is not a new concept. Instead, what is new is the developing interest in and understanding of this important area of the brain.

Rehabilitation and Behavior Management

As noted by Satz and Fletcher (1981), the therapeutic role of the neuropsychologists is emerging. A major and salient trend in human neuropsychology is the move away from the classic diagnostic role toward that of intervention/therapy (Diller & Gordon, 1981; Horton & Miller, 1984; Horton & Wedding, 1984).

One strong trend in the therapy of the brain-impaired is the use of behavior modification with the brain-injured (Horton, 1979; Horton & Wedding, 1984). Recent research documents excellent results (Horton & Wedding, 1984). Another exciting trend is the use of computers in rehabilitation. Lynch (1981) at the Palo Alto Veterans Administration Medical Center, for example, has adapted video games for retraining purposes. In a similar trend, Seron, Deloche, Moulard, and Rovsller (1980) have devised a computer-based therapy for the treatment of aphasic patients with writing problems. Still another potentially rich treatment option is the combination of behavioral and pharmacological agents (Pirozzolo, Campenella, Christensen, & Lawson-Kerr, 1981). Similarly, the use of acetylcholine precursors (e.g., lecithin) to improve cognitive skills in the aged has produced some positive findings (Davis & Berger, 1979). The potential of combining behavior modification and appropriate pharmacological agents is untapped and clearly in need of careful study.

New Technology

Over the last twenty years more accurate diagnostic techniques have been developed. The EEG can now be analyzed using averaged evoked potentials. While the advances in metabolic monitoring have been useful, the traditional radiographic techniques need additional improvement in detection of mass lesions. The first and still most commonly used of the new generation techniques is computerized axial tomography (CAT), in which a device rotates around the patient's head emitting x-ray beams later deciphered by x-ray sensitive detectors (instead of the traditional x-ray film). As a rule, multiple horizontal slices extending from the base of the skull to the vertex are photographed several millimeters apart. More recent developments include dynamic spatial reconstruction (DSR) techniques, which provide a three-dimensional perspective (rather than the two-dimensional one provided by CAT scan) of the brain. Positron-emission transaxial tomography (PETT) combines mass localization and metabolic detection methods by providing a phasic (rather than the usual static) presentation of metabolic activity of the brain. The most promising and newest of these scan methods is nuclear magnetic resonance (NMR), which uses radiation to provide a proton-base developed image of the brain. As exciting as these new diagnostic techniques are, they still fail (because of the inherent aspects of the technology) to provide an adequate presentation of human behavior. Since the neuropsychologist is beginning to use these methods as adjuncts to both research and clinical activities, further developments hinge on a close relationship between these two approaches (e.g., Swiercinsky & Leigh, 1979; Wedding, 1980).

New Populations

Numerous disorders that have traditionally been considered as functional in origin appear to have at least a limited neural basis. This has been the case not only for disorders such as schizophrenia, but for disorders for which, in the past, neural involvement was considered unimportant, such as depression (e.g., Ross & Rush, 1981). As a consequence, neuropsychological inquiry into the neural basis for psychopathology in general should be extended much further than its current boundaries.

According to Costa (1983), increasing interest should also be shown to patients from various fields of clinical medicine, especially those involving systemic disease. Neuropsychology can provide valuable understanding in the treatment of such chronic diseases as lupus, chronic obstructive lung disease (emphysema), cardiovascular disorders, and certain types of oncological disorders. The assessment of the effects of administration of pharmaceuticals for general medical disorders (e.g., high blood pressure) also warrants further attention. In this respect, any medical complication or treatment having a direct or indirect impact on neural integrity should be considered within the scope of neuropsychology.

CONCLUSIONS

In the preceeding discussion, efforts were devoted to conceptualizing human neuropsychology and the historical context of neuropsychology was summarized. Current relations with traditional medical and selected nonmedical specialties were also examined, albeit quickly. Finally, attention was devoted to emerging trends in human neuropsychology and some exciting possibilities for the future were described.

From the aforementioned discussion a few conclusions naturally follow. First, human neuropsychology is a promising discipline with the potential for service to humanity. Second, change in terms of role functioning, techniques, concepts, patients served, and technology is a fact of life that is more salient with each passing day. Third, the degree to which human neuropsychology realizes its potential to be of service will be in large measure due to its ability to adapt to the previously mentioned changes.

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