HANDBOOK OF NEUROPSYCHOLOGY

Section Editors

F. BOLLER
J. GRAFMAN
G. RIZZOLATTI
H. GOODGLASS

VOLUME 1

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Preface

In recent years there has been an enormous increase in interest into disorders of higher cortical functions and into brain-behavior relationships. The Handbook of Neuropsychology has been planned as a reference source that will provide for the first time comprehensive and current coverage of both experimental and clinical aspects of neuropsychology. To this end the chapter authors have produced in-depth reviews that go beyond a summary of their results and points of view. Each chapter is up-to-date, covering the latest developments in methodology and theory. Discussion of bedside evaluations, laboratory techniques, as well as theoretical models are all to be found in the Handbook. In addition, the editors have attempted to make the Handbook as coherent as possible by encouraging minimal overlap in topic matter.

The first section introduces historical developments in neuropsychology, approaches to the clinical and experimental assessment of higher cortical functions, as well as statistical and methodological issues. In addition, the introduction covers cerebral dominance, and specialization as well as models of cognition. Section Two (Topic Editor: Professor G. Rizzolatti) deals with normal and disordered attentional processes in experimental animals and in humans. Section Three (Topic Editor: Professor H. Goodglass) encompasses language, aphasia, and related disorders; it is shared over Volumes 1 and 2. This section emphasizes both the classical syndromes of aphasic disorders as well as the contribution of modern neurolinguistics. Special issues include bilingual and polyglot aphasia, disorders of sign-language, aphasia in left-handers, as well as recovery and therapy of aphasia. This section concludes with chapters on disorders of gestural behavior and apraxia.

Section Four (Topic Editor: Professor A. Damasio) will address the topic of disorders of visual behavior. It will cover experimental issues in animal and man, disorders of recognition, visuospatial analysis (including constructional apraxia), imagery, blindsight, and visual neglect. Section Five (Topic Editor: Professor L. Squire) will deal with memory and its disorders. Specific topics will include clinical assessment, the role of specific brain regions and etiologies in memory and its disorders, as well as specific syndromes such as post-traumatic amnesia, transient global amnesia, and functional amnesia. This section will conclude with chapters on rehabilitation and pharmacologic treatment of memory disorders.

Section Six (Topic Editor: Professor G. Gainotti) will cover emotional behavior and its disorders. It will include a review of theories of emotion, of the anatomical and

neurochemical bases of emotion, lateralization of emotion, as well as specific disorders of emotion and emotional arousal. Section Seven (Topic Editor: Professor R. Nebes) will deal with the neurobehavioral sequelae of congenital and surgically induced lesions of the corpus callosum and hemispherectomy in animals and humans. Section Eight (Topic Editor: Professor S. Corkin) will address issues related to aging and dementia. It will cover the neuropsychology of aging in animals and humans; clinical and pathological correlates of dementia; as well as modern clinical and experimental techniques such as PET and NMR Spectroscopy. Also included will be chapters on psychiatric symptoms in dementia, sleep studies of demented patients, statistical considerations, and issues related to pharmacological therapy of dementia. Section Nine will be concerned with cognitive models.

The Handbook is expected to be an essential reference source for clinicians such as neurologists, psychiatrists, and psychologists, as well as for all scientists engaged in research in the neurosciences.

Many persons have contributed to the successful preparation of the Handbook. The initial phases of preparation benefitted from the encouragement of Mr. Jaap DeVries at Elsevier and Prof. George W. Bruyn, one of the Chief Editors of the Handbook of Clinical Neurology. Long hours have been spent by the Topic Editors both in the planning stage and in the actual compiling of the various sections. Ms. Annette Grechen in Pittsburgh and the editorial staff of Elsevier in Amsterdam have provided invaluable technical assistance.

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Introduction

editors

F. Boller and J. Grafman

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CHAPTER 1

Neuropsychology: past, present and future

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Introduction

Human neuropsychology is the discipline that investigates on an empirico-scientific level the interrelations of the brain with mentation and behavior. It is a compound discipline in that it represents the confluence of several fields of study – neurology and psychology, neuroanatomy and neurophysiology, neurochemistry and neuropharmacology. Addressing one of the oldest of philosophic themes, the mind – body problem, neuropsychology has a long past. However, the term itself is relatively new (Bruce, 1985), having gained currency only in the 1950s when it displaced older terms, e.g. psychoneurology (Bekhterev), brain pathology (Kleist).

Since it is an amalgam of a number of fields of study, the status of neuropsychology through the ages has been dependent upon the status of its contributory disciplines. For example, on the psychological level, when mentation was classified into a few broad categories such as 'perception', 'cognition' and 'memory' (as was the case up to 1800) or personality dissected into complex traits such as 'benevolence', 'acquisitiveness' and 'reverence' (as Gall did), there was little hope of identifying specific cerebral correlates in them. On the anatomic level, it was scarcely possible to relate cortical variables to behavior when, as was generally the case up to the 1820s, the gyri of the cerebral cortex were regarded as 'enteroid processes' that were not even deemed worthy of being given a name (cf. Schiller, 1965). Nor could much understanding of the neural mechanisms mediating normal and disturbed speech be gained when, despite excellent clinical descriptions of aphasic disorders, 18th century physiology proposed that sluggishness in brain function caused by dryness and rigidity caused these disabilities (cf. Benton and Joynt, 1960). Thus the history of neuropsychology has been one of irregular progress as advances in one or another of its contributory disciplines were achieved and made an impact on thinking and practice in the field.

The period of 1861 – 1875 stands out as one of very rapid progress when concurrent advances in clinical neurology, anatomy, physiology and psychology combined to effect a transformation of the field and give it a new structure. Broca's (1863, 1865) correlation of non-fluent aphasic disorder with anterior left hemisphere disease initiated a new era of lesional localization and gave rise to the concept of hemispheric dominance. Meynert's (1867) researches identifying projection, association and commissural pathways, as well as regional differences in the cellular architecture of the cerebral cortex, provided an anatomic basis for the postulation of neural mechanisms underlying cognitive functions, the most important of which were Wernicke's (1874) models of the neurological basis of diverse language performances (cf. Geschwind, 1967). The psychological counterpart of Wernicke's neural connectionism was the associationist psychology of Wundt, presented in his published lectures in the 1860s and his book on 'physiological psychology', the first edition of which appeared in

1874 (cf. Boring, 1950). Wernicke's correlation of fluent aphasic disorder with left posterior temporal lobe disease complemented Broca's earlier localization of non-fluent speech disorder and was of major clinical and theoretical significance. The demonstration of the excitable motor cortex by Fritsch and Hitzig (1870) provided a powerful impetus for animal experimentation by physiologists and directed the attention of clinicians to the possibilities of cortical localization of function. Indeed, the Fritsch-Hitzig stimulation experiment was repeated on a human subject by Bartholow (1874).

The contemporary period is also one of very rapid change. The advent of the newer neurodiagnostic techniques of computed tomography (CT), magnetic resonance imaging, positron emission tomography, cerebral blood flow determination and evoked potential recording has ushered in a new era of lesional localization in which structural and functional abnormality of the brain can be demonstrated with greater clarity and precision than ever before. At the same time, advances in neurophysiology and neuropharmacology (won largely through the development and applications of single and multiple cell recording) and in anatomy (where hitherto unknown pathways have been identified) are providing valuable indications of the neural mechanisms underlying cognitive processes and leading to a revision of conceptions about the functional organization of the brain. On the behavioral side of the equation, application of standardized quantitative methods of assessment has disclosed performance deficits that had escaped attention and has served to correct biased observation.

Some topics have played a dominant role in the history of neuropsychology. The oldest are the perennial questions of localization of function in the brain and the nature of the cerebral mechanisms underlying thought and action. After Broca's revolutionary discovery in the 1860s, hemispheric cerebral dominance (itself a form of localization) became an issue of major importance. Certain types of behavioral disability were subjects of special interest, perhaps because of their striking character as well as their debilitating consequences. The earliest were disorders of memory and of speech. In the latter half of the 19th century, disturbances in perception, recognition and orientation (chiefly visual but also auditory and somesthetic) became prominent topics of study. General intellectual impairment, i.e. dementia, was recognized very early but did not become a major topic for research until well into the 20th century. On the other hand, the cognitive and personality changes associated with frontal lobe disease attracted special interest as early as the 1880s.

This chapter presents a brief and, of necessity, highly selective account of some aspects of the evolution of knowledge and thinking in the field of human neuropsychology. Current trends predictive of the likely directions of future development will then be considered.

Concepts of cerebral localization

Early conceptions

The earliest attempts to relate discrete mental functions or faculties to the brain (dating back to about 100 A.D.) took the form of a localization of functions along its anterior-posterior axis, either in the brain substance or in the ventricles. Of the two possibilities, ventricular localization was favored for a number of reasons. It accorded well with the doctrine of the circulation of animal spirits and, in addition, the hollow spaces within the brain seemed to be the more appropriate place for the noncorporeal soul to exert an influence on the body (cf. Pagel, 1958). In the scheme of Nemesius (ca. 400 A.D.), sensation and perception were located in the anterior ventricles, thinking and reasoning in the third ventricle and memory in the fourth ventricle. The concept provided a structural framework for a dynamic process wherein sensory impressions were received and integrated into perceptions in the anterior ventricles, moved to the third ventricle to be reflected upon, and deposited as memories in the fourth ventricle. In the absence of

a more convincing model, ventricular theory survived for a remarkably long time and derangement of the humors was often invoked to account for the occurrence of isolated defects in mentation. For example, the 15th century physician, Antonio Guanerio, explained anomia and paraphasic speech by postulating an excessive accumulation of phlegm in the posterior ventricle (the 'organ of memory') in the affected patients (cf. Benton and Joynt, 1960).

Localization of function in the substance of the brain largely displaced ventricular localization as a dominant approach in the 17th and 18th centuries. Thomas Willis conceived of sensation taking place in the corpus striatum, proceeding to perceptual integration in the corpus callosum and surrounding territory and progressing to memory in the cerebral cortex (cf. Clarke and Dewhurst, 1972). The 18th century French surgeon, La Peyronie, having observed that most parts of the cerebral hemispheres could be injured without producing obvious mental impairment, concluded 'from the facts and by way of exclusion' that the corpus callosum was the seat of intellect (cf. Soury, 1899). Transmission of animal spirits along distinct pathways was the physical basis of mentation and blockage in transmission produced disturbance in one or another mental function (cf. Clarke and O'Malley, 1968).

Gall

While relatively broad concepts of localization of function were the rule before 1800, a quantum leap to another mode of thinking was introduced by Franz Joseph Gall in the first decades of the 19th century. Placing mental functions in the cerebral hemispheres and insisting that the brain was in reality an assemblage of organs, each of which subserved a specific intellectual faculty or character trait, Gall made cerebral localization a central issue in neuropsychology. Although, with a few exceptions, his placement of these faculties and traits and his absurd phrenology provoked ridicule, his basic premise that the cerebral hemispheres formed a highly differentiated structure permitting precise localization of function. was taken quite seriously and engendered a decades-long controversy between 'localizationists' and 'antilocalizationists'. During this period (1820 – 1860), the systematic detailed descriptions of the cerebral hemispheres, the basal ganglia and the thalamus by Rolando, Burdach, Leuret, Gratiolet and other anatomists showed that the brain was indeed a highly differentiated organ, the parts of which were interconnected (cf. Meyer, 1971). For example in 1854, Gratiolet presented the first description of the optic radiations arising from the lateral geniculate nucleus and fanning out to the occipital and parietal cortex, thus providing an anatomic basis for the subsequent dethronement of the 'optic thalamus' as the cerebral center of vision and the placement of that center in the occipital lobes (cf. Polyak, 1955).

The specific aspect of Gall's scheme that aroused the greatest scientific interest was his placement of two centers of language, one for speech articulation and the other for the 'memory of words', in the orbital region of both frontal lobes. Conflicting clinicopathologic findings fuelled an acrimonious debate that was not resolved until the 1860s (cf. Benton, 1964).

The 'golden age'

Broca's discovery ushered in the 'golden age' of cerebral localization, extending roughly from 1870 to 1890. This period of intense activity, involving both animal experimentation and clinicopathologic correlations in patients, resulted in the localization of a variety of functions and capacities: e.g., visuosensory and visuoperceptive capacities in loci in the occipital lobes (Munk, 1878; Wilbrand, 1887), somatosensory and somatoperceptual capacities in the parietal lobe (Wernicke, 1895), learning capacity and memory in the frontal lobes (Bianchi, 1895). From a scientific standpoint, it seemed clear to most students that specific regions of the cerebral hemispheres sub-