Clinical Neuropsychology: A Brief History

Article *in* Disease-a-month: DM · April 2007

DOI: 10.1016/j.disamonth.2007.04.003 · Source: PubMed

Clinical Neuropsychology: A Brief History

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Clinical Neuropsychology is the discipline that investigates the interrelations of the human brain with thinking and behavior on the basis of the variations in brain function produced by injury or disease. That such injury caused mental impairment must have been apparent even to primitive man who resorted to trephining in an attempt to alleviate its pernicious effects.

Interestingly, emphasis was placed not only on the brain substance itself but also on the fluids, which it enclosed, ie, the ventricles. Early Greek physicians (eg, Nemesius ca. 400 A.D.) placed sensation and perception in the lateral ventricles, reasoning in the third ventricle, and memory in the fourth ventricle. This ventricular concept accorded well with the doctrine of the circulation of animal spirits. Moreover, it provided a structural basis for a dynamic process wherein sensations were integrated into perceptions in the lateral ventricles, moved to the third ventricle to be reflected upon, and consolidated as memories in the fourth ventricle. In the absence of better alternatives, "ventricular" theory survived for a remarkably long time. It was displaced definitively by "brain substance" concepts only in the 17th and 18th centuries.

It is also worth recalling that Aristotle, the greatest natural scientist of the ancient world, maintained that the heart was the seat of thinking and emotion, assigning the brain only the function of cooling the heat generated by the heart. His conclusions were based on sound empirical study. He noted that the exposed brain of animals was cold to the touch and that poking the brain surface did not elicit movements or signs of feeling. In contrast, the heart was warm and active; it accelerated during excitement and was slower during periods of calm.

Aristotle's cardiocentric concept of the seat of mental life had many supporters during the Middle Ages, the Renaissance, and even as late as the 17th century. That it was widely accepted is reflected in our language today. We still "learn by heart"; we offer "heartfelt sympathy"; and we "lose our heart" when we fall in love.

Dis Mon 2007;53:142-147
0011-5029/2007 $32.00 + 0
doi:10.1016/j.disamonth.2007.04.003

By the end of the 17th century, however, the brain had largely displaced the heart as the organ of mind. Thomas Willis (1621–1673) localized perception in the corpus callosum and memory in the cerebral cortex. Francois La Peyronie (1678–1747) placed intelligence in the corpus callosum. Emmanuel Swedenborg (1688–1772) seems to have been alone in deciding that intellectual functions were a distinctive property of the cerebral cortex. Swedenborg also believed that the basal ganglia were centers of motor control.

These broad concepts of cerebral localization were the rule in the early 18th century. A quantum leap to another mode of thinking took place in the early decades of the 19th century when the anatomist and phrenologist Franz Joseph Gall (1758–1828) expounded his ideas and made them a central issue in neurophysiology and neuropsychology. Gall's basic postulate was that the human brain was not a single organ but an assemblage of organs, each of which formed the material substrate of a specific cognitive ability or personality trait. Apparently he found no difficulty in identifying the locus in the human brain of about 30 mental characteristics, most of which he took from the analyses of the Scottish school of psychology, represented by Thomas Reid (1710–1796) and Dugald Stewart (1753–1828).

Gall's hypothesis that the human brain is not a unitary organ but instead consists of an aggregate of specialized cortical areas attracted both loyal supporters and vigorous opponents. One salutary effect of the controversy was to stimulate detailed anatomic study of both cortical and subcortical regions. For example, in 1854, Pierre Gratiolet (1815–1865) 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 abandonment of the thalamus as the cerebral center for vision and the placement of the end station in the occipital lobes.

At the same time, the gyri and sulci of the superior, lateral, and mesial aspects of the human cerebral cortex were described and named so that, by 1860, illustrations of the cortical surfaces were essentially the same as those to be found in present-day textbooks.

In the 1860s, the momentous (and counter-intuitive) discovery of Paul Broca (1824–1880) that speech is mediated by the left hemisphere added a new dimension to brain function, that of hemispheric cerebral dominance. The observation that aphasic patients often suffered from cognitive deficits that were of a non-verbal as well as a verbal nature had the effect of broadening the concept of left hemisphere dominance to include cognitive functions. Thus, the left hemisphere became, in the minds of many clinicians, the "intellectual" hemisphere.

The demonstration by Gustav Fritsch (1838–1927) and Eduard Hitzig (1835–1907) in 1870 that electrical stimulation of the precentral gyrus produced movement in the contralateral limbs was as revolutionary in its way as Broca's discovery of the role of the left hemisphere in speech had been. It provided the impetus for intense efforts during the ensuing decades to localize the functional properties of each and every gyrus in the cerebral cortex, a period called the "golden age" of cerebral localization.

In 1873, Roberts Bartholow, a Cincinnati physician, took advantage of the circumstance that one of his patients had a skull defect that permitted stimulation of the exposed cortex to confirm the Fritsch–Hitzig finding in a human subject. Bartholow was censured for what was considered to be unethical conduct for this initiative. Today, such stimulation of the exposed human cerebral cortex during the course of neurosurgery is commonplace.

Yet during this "golden era" of localization, there were thoughtful students of the nervous system who objected to this placement of numerous cognitive capacities in sharply delimited cortical centers. They found it inconceivable that a restricted aggregate of nerve cells could be the seat of a complex intellectual function. Hughlings Jackson (1835–1911), who was well aware of the facts of clinical localization and applied them in his neurological practice, cautioned that identifying the lesion that leads to an aphasic disorder was not the same as identifying the locus of speech. In short, he accepted the concept of centers for its clinical utility, but not as a neuropsychological theory.

Jackson's conception of the nature of aphasic disorder was also incompatible with the notion of cortical centers. He maintained that aphasia always entailed an impairment in intellectual functioning, a position that was diametrically opposed to that of Carl Wernicke (1848–1904) who insisted that there was no intrinsic connection between aphasia and intelligence.

One or another of Jackson's ideas was later expressed in the 1880s and 1890s by the physiologist, Jacques Loeb (1859–1924), by Sigmund Freud (1856–1939), who was then a neurologist as well as a psychiatrist, and by the philosopher Henri Bergson (1859–1941). Their approach to the problem of localization in turn influenced the thinking of some early 20th century neurologists such as Arnold Pick (1851–1924), Henry Head (1861–1940), and Kurt Goldstein (1878–1965).

On the whole, however, mainstream neurology remained wedded to the doctrine of cerebral centers and interconnected conduction pathways, the "telephone system" conception of the functional organization of the brain. No doubt many neurologists regarded the concept of centers as a fiction, although it was a convenient and useful fiction. For example, H. Charlton Bastian (1837–1915), a leading 19th century authority on aphasia, believed that the cerebral substrates of speech were, as he phrased it, "diffuse but functionally unified nervous networks." Nevertheless, he wrote that, although he did not accept the common conception of a neatly defined center ". . .for the sake of brevity it is convenient to retain this word and refer to such networks as so many centers." Thus, the concept of centers was of some heuristic value in clinical practice in that it pointed to the probable locus of a suspected focal lesion.

Hemispheric Cerebral Localization

As has been mentioned, following Broca's discovery that the left hemisphere was endowed with a broader significance, encompassing cognitive functions beyond the realm of speech, it became indeed the *dominant* hemisphere in all respects. During this period, when the left hemisphere was assigned importance for cognitive function, there were scattered attempts to suggest that the human right hemisphere possessed its own distinctive cognitive capacities, particularly those expressed in visuospatial performances, in route finding and in geographic orientation.

In the face of neurosurgical findings that the whole right hemisphere could be extirpated without causing major cognitive disability, however, these suggestions were ignored. The most that could be said was that the right hemisphere might possess *left* hemisphere abilities in latent form, capacities that under some circumstances could be brought into play when the left hemisphere was damaged.

The empirical studies of the British psychologist Oliver Zangwill (1913–1986), and the French neurologist Henry Hecaen (1912–1983), initiated during and shortly after World War II, demonstrated conclusively that patients with right hemisphere disease did show a very high frequency of specific visuosperceptual, visuospatial, and constructional defects.

The Zangwill–Hecaen studies had a number of consequences. Their implications led to a widespread exploration of the role that the right hemisphere might be playing in the mediation of different aspects of cognition. The result was that a remarkably diverse array of capacities and attributes, far beyond the visuoperceptual and visuoconstructional defects described by Zangwill and Hecaen, were reported. Among the disabilities ascribed to right hemisphere dysfunction were slowed reaction time, mood disorders, auditory defects, and even speech impairments that conventionally had been considered signs of left hemisphere disease.

A Summing Up

This brief historical survey has outlined some of the successive stages in the evolution of concepts of the relationships between brain function and behavior. Clinical observation alone provided most of the data upon which the conclusions were drawn.

Herbert Birch (1918–1973), the renowned investigator of human development, was fond of pointing out that concepts of the nature of brain function tended to reflect the dominant technology of a period. In classical times, the ingeniously designed aqueducts, dams, and waterways were the products of a remarkably advanced hydraulic technology. Ventricular theory (rather than "brain substance" theory) was consonant with that technology.

The late 19th century witnessed the development and eventually universal application of a transforming new system of communication: the telephone. Not surprisingly, the notion that the brain can be conceived as being one immensely complicated telephone system was readily accepted. Today the brain is a "computer."

It is nothing of the sort. Of course, the brain can compute (badly). It is not an efficient computer because it is fundamentally different from even the most complex computer, even those modifiable ones that are capable of learning and self-correction, ie, those that can be said (not unfairly) to possess intelligence. The brain is a living organ that is both sensitive to internal and external stimuli and that has the capacity to apprehend these stimuli and to deal with them as best it can. The brain does not necessarily discharge its task very efficiently. There is just too much on its plate. It is a generative as well as a multisensory organ. It must impose order on the internal and external world and reach at least a partial view of the nature of the real world.

Given the complexity and varied nature of the stimuli and events with which the brain must deal, this is a truly daunting task. It is not surprising that it often makes mistakes. That, in fact, it often makes mistakes is amply documented by the innumerable false conclusions reached through observation and experimentation over the centuries.

What then accounts for the advances in knowledge and control that have been achieved over the centuries? We could say that it is the creativity which is reflected in the *tools* of investigation that have been developed: the microscope, the x-ray, current neuroimaging procedures. Without the microscope there would be no histology and hence no histopathology.

Without x-ray we would have no direct knowledge of the status of the brain in living patients. Our understanding is made possible by (and limited by) our remarkable neuroimaging procedures. No doubt these procedures will be displaced by even more informative techniques that permit deeper insight into the nature of brain function and brain-behavior relationships. The future of the discipline of neuropsychology should be very bright.

If you wish to further explore the history of neuropsychology, the following references are available for your examination:

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