Book Reviews

Neurophysiological History

Mind, Brain and Adaptation in the Nineteenth Century. Cerebral Localization and Its Biological Context from Gall to Ferrier. ROBERT M. YOUNG. Clarendon (Oxford University Press), New York, 1970. xiv, 478 pp. $10.50.

"Psychology," said Norbert Wiener, "is like a tapeworm that keeps losing segments to physiology." This is essentially the message of this absorbing book, which traces the history of the concepts of cerebral localization of function and (in much less detail) of the relation of organisms to their environments.

Young chooses for his starting point Franz Joseph Gall. In the first section of the book, Gall's major tenet—that mental faculties must have their seat in the brain—is followed through from its initial launching in terms of cortical localization to its final shipwreck in the form of cranioscopic mapping. Gall's basic hypothesis was that striking behavior of a given kind implies enlargement of a certain cortical region causing the skull above it to protrude. His methodology was the collection of hundreds of skulls and of anecdotes about individuals (but not the owners of the skulls) who exhibited aberrant behavior of some kind. Gall's Collection of casts is famous and, though it was dispersed to some extent by the Germans during the occupation of Paris, most of it can still be seen at the Musée de l'Homme. From time to time specimens of these moulages turn up in the antiquary shops of the Left Bank, from which some have found their way to the Biomedical Library at the University of California at Los Angeles. They document the point that Gall focused his attention on extremes of cranial deformity, which led him by a tenuous illogic to correlation with extremes of behavior. He also attached importance to size of skull, and one wishes that he had had the opportunity to palpate the head of Anatole France, famous as being the smallest in Paris, and as puzzling as the tiny skull of Descartes.

Once again, one is surprised that so fine an anatomist as Gall should have relied on such a shaky methodology. Credit must, however, be given to him for his conception that the brain is the organ of the mind. In this age this sounds almost like a platitude, but for Gall it meant curtailment of his lectures in Vienna, proscribed by the Emperor as being, in their sheer materialism, opposed to morality and religion. For this reason his writings reach us in the French language, for he moved to Paris. There he was, on his death, refused a religious burial, his works having been put on the Index.

The next section takes us on to a study of Gall's archenemy, Pierre Flourens. More important than the acrimonious wrangles between these physiologists, however, was the introduction by Flourens of the experimental method into the search for cerebral localization.

Flourens's method, in brief, was that of ablation—he removed a piece of the brain, observed a behavioral loss, and concluded that the lost behavior had resided in the piece he had removed. This interpretation of such observations became the basis for the concepts of "brain centers" that lasted almost into the present. Only in what one may perhaps be allowed to call post-Fulton times has the recognition of circuits rather than centers come into prominence in neurophysiology, and this largely because of the revelation of two powerful modes of neuronal behavior: active inhibition and feedback control.

For the period covered by this book, the interpretations based on ablation experiments remained extremely influential. One must note, however, that what Flourens observed were changes in motor behavior, from which he inferred changes in sensation, from which, in turn, he inferred the "psychological" attributes of perception, judgment, memory, intelligence, volition. These are Gall's "mental faculties," and Flourens really came no closer to their localization than had the man he despised.

In fact, Flourens's localizations were very generalized, being divided among the medulla, the cerebellum, and the cerebrum; within the cerebral hemispheres (to which he denied a role in sensation or motion) he differentiated no substations for function, regarding the hemispheres as unitary "organs." This view formed an impediment to progress in brain research (as did the, in some ways, similar view of Lashley in our own times).

The story moves on to Magendie and his unequivocal experimental approach. Some brief mention is made of the Idéologues—in this reviewer's opinion, too brief, for their influence on French thought was very great, reaching as it did to the Écoles Normales established by the Convention and hence into medicine in the training of alienists. Not only psychology but psychiatry, too, was profoundly affected by the philosophy of Destutt de Tracy and Condorcet, which was passed on by them to Cabanis and Pinel. And in his physiology Magendie followed Cabanis. This philosophy, so influential in France and England, did not appeal to the physiologists of Germany, where Müller, still retaining the mark of Schilling's Naturphilosophie, was the outstanding leader. Because Müller rejected Gall and believed the brain to be inexcitable, he holds only a negative place in the history of cerebral localization.

Young then leads us through a review of the history of association psychology—a history studded with such stars as Hobbes, Locke, Hume, Hartley, the Mills, Herbert Spencer, and Bain. Not one of these was a physiologist, not one of them an experimentalist, but it is Young's thesis that Spencer was the major influence on Ferrier, the outstanding pioneer of experimental cortical localization, and on Hughlings Jackson, who brought the subject into the clinical field.

In emphasizing the concepts of sensation promulgated by the Idéologues and directly derived from Locke, Young fails to give credit to Condillac for insisting on the importance of motion: "C'est que le mouvement, qui en est la cause physique et occasionelle, se reproduit dans le cerveau." Tracy insisted on this even further and, though concerned primarily with the sensations evoked by movement, he recognized activity in what we now call efferent nerves, activity which he, like Baglivi before him and Hartley in his own day, regarded as vibration.

It is surprising to find a whole chapter given to Bain, who contributed nothing of substance to our knowledge of cerebral localization or of evolution. Bain laid stress on motion and added

"muscular sense" to the usual five. He can hardly have read Tracy, for he claimed that no "writer on the human mind" had advanced the concept of spontaneous movements; these were the movements which Tracy considered "peut-être très nombreuses aussi, qui ne sont la source d'aucune perception."

Young gives the center of the stage to Herbert Spencer, that strange character who could have come to eminence only in the Victorian age. Starting with an extreme belief in phrenology which he later almost completely shucked, Spencer worked his way to his "Universal Postulate," his ultimate criterion of belief: that "in the last resort we must accept as true a proposition of which the negation is inconceivable." This reminds us of Locke, who gave as example the belief that the dead shall rise again—a belief impossible to test. But it is Spencer's later change from phrenologically derived psychology to association psychology, which he eventually united with the theory of evolution, that led to the concept of adaptation of man to his environment.

It was Spencer's belief that localization of functions ("the concentration of special kinds of activity in special places") must exist in the brain that was attractive to Hughlings Jackson, who became the outstanding proponent of sensorimotor physiology in the West. In Eastern Europe, Sechenov's *Reflexes of the Brain* (unmentioned by Young) was making its stormy way toward acceptance. Written by an experimentalist, it went much farther than Thomas Laycock's speculations on the same theme.

Speculation gave way finally to experiment when, in 1870, Fritsch and Hitzig found that, contrary to all previous opinion, the cortex was excitable and moreover possessed areas specifically excitable for well-defined muscle groups. Localization of the motor cortex therefore ousted the corpus striatum from the false position it had been assigned (even by Hughlings Jackson).

Objective localization of sensory cortex (far more difficult to achieve) followed within a decade, but went unnoticed by the psychologists of the 19th century (as it goes unnoticed by Young). It had been assumed a priori impossible to detect, let alone locate, sensory impressions except by the crude technique of ablation, as used by Munk (what Gall called mutilation), but within five years of Fritsch and Hitzig's delineation of the motor areas a new technique, not for stimulating but for recording from the unmutilated brain, provided the objective demonstration of the cortical localization of sensory modalities that is used to this day. Responses to visual stimulation proved easier to localize than those for other modalities, as indeed they are now, but the differentiation of the area involved from the area of response to sound was mapped and the intermingling of sensory and motor in the neighborhood of the motor strip discovered.

But Caton's reports (1875, 1877, 1887, 1891) and Beck's extended study of the same phenomena (1890, 1891, 1892, 1895, and later) went unnoticed by Spencer, Ferrier, and Hughlings Jackson (though not by Victor Horsley). Beck's maps of rabbit and dog brains show the specific locations for responses to sight and sound and to stimulation of the various limbs. These discoveries were published in the *British Medical Journal* and the *Centralblatt für Physiologie*, the outstanding journals in an era less flooded with periodicals than our own, and were even reported at the ninth International Medical Congress and at the second International Congress of Physiology. So lack of recognition of their importance by at least two generations of psychologists in the West (though not in Eastern Europe) remains a mystery. Even Young makes no mention of these achievements.

Ablation as a method for localization has fallen from favor among neurophysiologists, who are now aware of the imbalance it produces in the remaining circuitry of the brain, and the years that have followed Ferrier have only served to pile up the evidence against the idea of specific highly localized cortical areas. The sensorimotor strip is not as closely segregated into motor and sensory mechanisms as was once thought, nor are the primary sensory projections the sole receivers of sense modalities. And cortical exploration has not revealed the sites that Gall sought for the various faculties. One has to delve below to seek evidence for systems that subserve memory, emotion, and the drives of sex, hunger, and thirst that come to us down the evolutionary trail. Brain "centers" have given way to "systems." The 19th-century localizers believed they had laid to rest the notion of the ancients that the heart was the site of emotional qualities, and they did not foresee that the following century was to recognize the interplay, by feedback, of cerebral and visceral mechanisms. Gall's use of the words "mental faculties" covered many complex qualities that well may, like the lists of Bain and of Spencer, reflect this interplay. Where do these reactions lie? "Tell me where is fancy bred, or in the heart or in the head?"

There is a clue in the introduction to this book that Young may be planning a further study. His readers will be waiting for it, for this volume is of unusual excellence. Read it.

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Artificial Vision

Visual Prosthesis. The Interdisciplinary Dialogue. Proceedings of a conference, Chicago, June 1969. T. D. STERLING, E. A. BERING, JR., S. V. POLLACK, and H. G. VAUGHAN, JR., Eds. Academic Press, New York, 1971. xviii, 382 pp., illus. $18.50. Association for Computing Machinery Monograph Series.

Although it appears at the very end of this unusual book as appendix B, the section "Blindness in the United States" could well be the part to be read first, particularly by those not acquainted with the extent of blindness and the problems it causes. The economic, moral, and social grounds for pursuing the daring thoughts and experiments recorded in the remainder of the book are established by the demographic analyses in this appendix.

The book is the first of its kind, the first volume to be devoted almost exclusively to the somewhat controversial topic of visual prosthesis achieved by surgical intervention and device implantation somewhere in the human visual system. It contains as appendix A the otherwise almost unavailable summary of the first conference on visual prosthesis held in Cambridge, Massachusetts, in 1966. The bulk of the book, though, comprises a supplemented record of the exciting proceedings of the second conference.

Central to the materials covered in the book is the concept of artificial vision created through controlled patterned stimulation of phosphenes in blind persons by means of arrays of stimulating electrodes. The signal work of G. S. Brindley and W. S. Lewin, who have implanted a device in a human and studied the parameters of phosphene screen production, is re-