THE initiation of modern neurological surgery was made possible by three discoveries in the nineteenth century. The introduction of two of these, anesthesia and antisepsis, vastly increased the scope of surgery in general, and made brain surgery feasible technically. Such operations were performed rarely, however, because there was no way to locate lesions that did not involve the skull. The problem was solved when it was discovered that in the brain there is focal representation of bodily function. This third fundamental concept—cerebral localization—became an important part of the foundation on which modern neurosurgery was built.14

Since the dawn of recorded surgery it has been recognized that brain injuries are sometimes accompanied by localized losses of bodily function. In the fifth century B.C., Hippocrates noticed the association between brain damage and aphasia, ophthalmoplegia, and anisocoria2 3 He also recognized that unilateral brain injury occasionally is followed by convulsions or paralysis of the opposite side of the body2 3 However, for twenty-three centuries there were no scientific theories advanced to explain these associations. Instead, interest in cerebral physiology centered around philosophical discussions of the seat of the soul.9,13,17

In the early nineteenth century Franz Joseph Gall and Johann Caspar Spurzheim advanced a pseudoscientific theory of brain localization known as phrenology.7,9,15,17 These men believed that various subdivisions of the brain governed various intellectual activities, and that the relative development of the subdivisions could be assessed by examination of the overlying cranium. Although certain aspects of their theory were correct, most of their ideas were so absurd that the entire theory was rejected by most scientists. Especially opposed to the concepts of cerebral localization and phrenology was Pierre Flourens, whose studies on animals indicated to him that cerebral gray matter was homogeneous and equipotential. Flourens was an established physiologist, and his authoritative views were accepted for half a century.13,16,17

However, clinical evidence to the contrary was accumulated. For example, Jean Bouillaud and Paul Broca found that injuries to the third left frontal convolution resulted in motor aphasia, and Hughlings Jackson defined the relationship between convulsions on one side of the body and disease of the opposite hemisphere.7,9,11,13,17 Related experimental studies did not support these clinical observations immediately, probably because of the crude laboratory apparatus then in use. In the early nineteenth century Luigi Rolando had observed muscular contractions during the electrical stimulation of the cerebral hemispheres of a pig.17 But it was not until 1870 that the doctrine of cerebral localization was placed on a firm basis by experimentation.

In that year, two young Berlin physicians, Gustav Fritsch and Eduard Hitzig, published the results of cerebral stimulation and ablation in dogs.2 Because there had been no suitable laboratories available to them, they did their first experiments in Hitzig’s home, operating on Frau Hitzig’s dressing table.8 Despite these modest facilities, Fritsch and Hitzig produced a classical work which opposed the prevailing concepts of cerebral function. Their experiments were confirmed by David Ferrier, and initiated a series of similar studies which made possible the first modern operations for localized cerebral lesions.17

Fritsch produced no scientific contributions of note after 1870, but Hitzig continued to contribute to the understanding of cerebral localization for 35 years.4–6,8
The Electrical Excitability of the Cerebrum

G. FRITSCtH AND E. HITZIG

Physiology ascribes to all nerves, as a necessary condition of the concept, the characteristic of excitability, i.e., the capability of responding with their specific energy to all the influences by which their state is changed at a certain rate. But for the central part of the nervous system other ideas exist, though to be sure certain aspects of these are not accepted generally. It would be too long a process and it would also not serve the special purpose of the present work if we wanted to mention from the enormous relevant literature only the results that seem to us reliable and that were obtained by stimulative experiments on all the separate parts of the central nervous system. However, while with regard to the excitability of the organs composing the brain stem there exists a very great difference of opinion regarding stimulations other than organic ones, while very recently a violent dispute broke out about the excitability of the spinal cord, the conviction generally has been held since the beginning of the century that the hemispheres of the cerebrum are absolutely not excitable by any stimuli familiar to physiologists.

Haller and Zinn\(^1\) alleged that they saw convulsive movements when the medullary substance of the cerebellum was injured. However, at that time people were too little accustomed to a strict limitation of the stimuli used, which meet almost insurmountable obstacles in the brain, to pay much attention to these data later. As Longer remarked, it is probable that those experimenters had penetrated up to the medulla oblongata with their instruments.

But Longer\(^2\) himself says the following on the subject:

"On dogs, rabbits, and on some kids, we have stimulated the white substance of the cerebral lobes with the scalpel; we have cantered it with potassium, nitric acid, etc., we have passed galvanic currents in every direction through it, without succeeding in initiating involuntary muscular contractions or developing convulsive twitchings; the same negative result was obtained by directing the same agents toward the gray or cortical substance."

Magendie’s vivisections\(^3\) led to the same results. Later we shall deal with the rather similar conclusions of Flourens which are based upon results of bisections and denudations.

Matteucci\(^4\) also found the cerebrum and cerebellum of the rabbit to be entirely nonexcitable by electrical stimuli.

Van Deen,\(^5\) with whose name the theory of non-

\(^{5}\) Moleschott’s Untersuchungen u.s.w. vol. VII, no. IV, p. 381.