phrase, they "blundered into death" (Garrison). His decorticated dogs were able, on the other hand, to walk with adequate coordination, indicating that the pallium was not a requisite to the walking reflexes. However, the animals with frontal decortications were extremely restless, pacing the floor most of the time, and at the slightest annoyance growling and snapping viciously (sham rage).[7] From these experiments he drew the conclusion that the site of integration of pseudoaffective mechanisms is subcortical. In this realm Goltz was the forerunner of Bard,[8] who in 1928 noted from his famous ablation experiments in cats that neural structures in the hypothalamus made possible the expression of angry behavior, as did Walter Rudolph Hess (1881–), in 1948, by means of implanted electrodes.[9,10]

A debate with Ferrier was brewing, an echo of an earlier one (during 1861) in which the prestigious Gratiolet countered Bouillaud's and Auburtin's ideas on the cerebral localization of function, by exclaiming, "I do not hesitate to conclude that all attempts at localization which up to now have been tried, lack any foundation. They are no doubt great efforts, titanic efforts! But when one attempts to grasp the truth at the height of these babbles, the edifice crumbles."[11] The debate took place at the International Medical Congress in London in 1881.[12] "I will prove beyond the shadow of a doubt," challenged Goltz, "that Ferrier's theory [of localization of function] is completely false." Operated (decorticated) dogs Goltz had brought along performed astonishingly well. Ferrier, in reply, remarked: "If I cannot argue with him—and I must differ with him widely—it is not because I dispute his facts. . . . But I reject his conclusions." Ferrier's demonstrations on monkeys left no doubt in the minds of the referees. The verdict was unanimously in Ferrier's favor. But Goltz, in his demonstrations, had left a strong impression. Sherrington, then twenty-four, decided then and there to enter the field of physiology. His first publication (with Langley) was on the anatomical aspects of spinal degeneration observed in Goltz's dogs.[13,14] He was a frequent visitor in Goltz's laboratory during the ensuing ten years.

Goltz's private life was one of even tenor. At thirty-four he entered into a happy marriage. To his colleagues he was brusque and

blustering, but among his rather narrow circle of friends he was noted for his ability as a raconteur and for his refreshing informality. The cut of his jaw and the intentness of his expression revealed a man of determination and persistence: it was these qualities of his character which helped to elevate him into the company of the great physiologists of the past century.

MOFFETT FIELD, CALIFORNIA WEBB HAYMAKER

References

[1]Königsb. med. Jahrb., 1862, *3*:271–274. [2]Virchows Arch., 1863, *26*:1–33. [3]*Beiträge zur Lehre von den Functionen der Nervenzentren des Frosches.* Berlin, Hirschwald, 1869. [4]Pflügers Arch., 1872, *5*:53–76. [5]*Ibid.*, 1874, *8*:460–468 (with Freusberg). [6]*Ibid.*, 1896, *63*:362–400 (with Ewald). [7]*Ibid.*, 1892, *51*:570–614. [8]Amer. J. Physiol., 1928, *84*:490–515. [9]Helv. Physiol. Acta, suppl. 5, 1948. [10]*Die funktionelle Organisation des vegetativen Nervensystems.* Basel, Schwabe, 1948. [11]Bull. Soc. anat. Paris, 1861, *36*:330–357, 398–407 (Broca, with discussion by Auburtin and Gratiolet). [12]Trans. Internat. Med. Congr., London, 1881, *1*:218–228, 234–237. [13]J. Physiol., London, 1884, *5*:*vi*. [14]*Ibid.*, p. 49–65.

References to Biography and Works: 1) Pflügers Arch., 1903, *49*:1–64 (contains annotated bibliography; Ewald). 2) *An introduction to the history of medicine.* Philadelphia, Saunders, 1929, p. 540–541 (Garrison). 3) *Reflex action. A study in the history of physiological psychiatry.* Baltimore, Williams & Wilkins, 1930 (Fearing). 4) Bull. N. Y. Acad. Med., 1954, *30*:559–578 (Stookey). 5) *Neurosurgical Classics.* New York, Johnson Reprint, 1965, p. 119–128 (Wilkins).

MARSHALL HALL (1790–1857)

THE reflex concept as we understand it today owes much to Marshall Hall, English physician and physiologist, born at Basford, near Nottingham. The son of the cotton manufacturer who first used chlorine for bleaching, he studied chemistry, as well as anatomy, and entered Edinburgh Medical School in 1809, where he was graduated three years later. After spending two years

Marshall Hall

as Resident House Physician to the Edinburgh Royal Infirmary and visiting the medical schools of Paris, Göttingen, and Berlin, he returned to Nottingham. Here he established himself as a very able physician, mainly known for a book on diagnosis[1]—a new topic in 1817—and for his advocacy of P. C. A. Louis's plea to refrain from excessive blood-letting.[2] Ten years later he moved to London where he conducted a large private practice, but he was never on the staff of a hospital and carried out his researches at home. He was made Fellow of the Royal Society in 1832 and of the Royal College of Physicians of London in 1841. Having retired from practice in 1853 he died four years later of a cancerous

Portrait from *Pettigrew's medical portrait gallery*, vol. 4, courtesy of the Wellcome Historical Medical Museum, London.

oesophageal stricture. He married at the age of thirty-nine; his only son became an eminent barrister.

Opinions differ concerning the personality of Marshall Hall. Some thought he was an unduly conceited little man, and indeed he did not suffer injustice without protest. No doubt brilliant, but overaware of his gifts, he could not establish the usual personal contacts. Yet Thomas Wakley (1795–1862), the outspoken Editor of *The Lancet*, supported Hall's claim that his contribution was equivalent to that of William Harvey;[3] others maintained that Hall's opponents were mostly envious of his ability. His wife's biography of him, as might be expected, is wholly laudatory.

Hall published nineteen books and over 150 papers; they teem with refutations, attacks, defensive arguments, and claims for priority. He did not always refer to the work of others, and on one memorable occasion he was accused of blatant plagiarism.[4]

His major researches, beginning in 1832 and extending over twenty-five years, concerned the physiology of the reflex: he claimed that he had devoted 25,000 leisure hours to them![5] The concept of the reflex has its roots in antiquity and Hall's work was a direct extension of that of Robert Whytt of Edinburgh (1714–1766), Albrecht von Haller of Göttingen (1708–1770), Georg Procháska of Prague (1747–1820), J. J. C. Legallois of Paris (1770–1840), and of many more. By 1830 there existed considerable experimental data on the reflex and the isolated spinal cord but little on the latter's reflex function. Hall's contribution to neurophysiology was to postulate an independent reflex system in the cord and spinal nerves, an "excito-motory system,"[6] or afferent-efferent in modern terminology. This system was in "the true spinal marrow," not in the "spinal chord" which contained the connections between brain and body. The nerves of the reflex system were distinct, and unrelated to volition, sensation, consciousness, or physical influences. Reflex activity was *through* the cord, and he therefore called the system "diastaltic"[7]—a term like others of his now long-forgotten. Nevertheless, Hall was the first to provide a basis for the concept of the neural arc in the spinal cord.

Opposition to it was widespread, partly on account of the man's personality and partly because he had excluded the soul, in certain quarters still deemed essential for all human activity. Support,

however, came from abroad where personality factors were not operative and where mechanistic views had displaced the need for the soul. The name of Johannes Müller of Berlin (1801–1858) is often linked with that of Hall, for his findings were similar.[8] The studies of these men were thus of vital importance in the evolution of the reflex concept and led directly to the significant advances of Sir Charles Sherrington of Oxford (1857–1952), I. M. Sechenov of St. Petersburg (1829–1905), and of F. L. Goltz of Strassburg (1834–1902) later in the nineteenth century.

Hall also described the grasp reflex,[9] though without appreciating its significance, and he studied the effects of drugs such as strychnine and opium on reflex activity. Furthermore he indulged in broad, if frequently erroneous, applications of the latter to diagnosis and treatment. But he was the first to make a clear reference to spinal shock,[9] also recognized by Whytt almost a century earlier and he observed muscle tone, especially that of the sphincters.

An original, postural method of artificial respiration[10] is one of the many topics Hall dealt with in the field of general medicine. The critical attitude displayed in his experimental work was often absent from his clinical investigations and his books on diseases of the nervous system[11] were never very popular. Epilepsy he thought was due to cervical cord irritation,[12] a view probably based on a misinterpretation of adversive seizures. Outside the medical field Hall demonstrated his versatility in papers on algebra and Greek grammar, and he was always ready to attack the evils of his day, such as American slavery (after a journey to the United States), flogging in the army, defective sewerage, and inadequate railway safety.

LONDON, ENGLAND EDWIN CLARKE

References

[1]*On diagnosis, in four parts.* London, Nottingham (printed), 1817. [2]*Researches principally relative to the morbid and curative effects of loss of blood.* London, Thames Ditton (printed), 1830. *Observations on blood-letting, etc.* London, 1836. Practitioner, 1909, *82*:320–331. [3]Lancet, London, 1846, *2*:154–157, 186–189, 244–247, 250. *Ibid.*, 1857, 2:172–175. [4]*London Med. Gaz.*, 1838, *2*:40–47, 72–73, 93–96, 128, 160, 218–219, 252–254. [5]Philos. Trans. Roy. Soc., London, 1833, *123*:635–665. [6]*Memoirs on the nervous system. Memoir II. On the true spinal marrow and the excito-motory system.* London, Sherwood, Gilbert & Piper, 1837. [7]*Synopsis of the diastaltic nervous system or the system of the spinal marrow and its reflex arcs, as the nervous agent in all the functions of ingestion and of egestion in the animal oeconomy.* London, Mallett, 1850 (Croonian Lecture). [8]London and Edinburgh, Phil. Mag., 1837, *10*:187–193. [9]See G. Jefferson in *Science, medicine and history* . . . in honour of Charles Singer, edit. by E. A. Underwood. Vol. 2. London, Oxford U. P., 1953, p. 303–320. [10]*Prone and postural respiration in drowning,* etc. London, 1855. [11]*Lectures on the nervous system and its diseases.* London, Sherwood, Gilbert & Piper, 1836. *On the diseases and derangements of the nervous system, etc.* London, Baillière, 1841. [12]*Essays on the theory of convulsive diseases.* London, 1848. *On the neck as a medical region,* etc. London, 1849.

References to Biography: 1) *Memoirs of Marshall Hall, M.D., F.R.S.,* by his widow. London, Bentley, 1861. 2) Lancet, London, 1850, *2*:120–128. 3) Lancet, London, 1857, *2*:172–175. 4) *Great doctors of the nineteenth century.* London, Arnold, 1935, p. 85–105 (Hale-White). 5) *Autobiographical recollections of the medical profession.* London, Churchill, 1874 (Clarke), p. 327–330. 6) *Reflex action.* London, Baillière, Tindall & Cox, 1930 (Fearing). 7) *Medical portrait gallery.* Vol. 4. London, Fisher, 1840 (Pettigrew). 8) Med. Hist., 1958, *2*:120–133. 9) *J.A.M.A.*, 1962, *181*:1132–1133; *18*:1341.

HERMANN von HELMHOLTZ (1821–1894)

HERMANN LUDWIG FERDINAND von HELMHOLTZ was born at Potsdam of a respected academic father and a mother who was descended from William Penn. He was a weakling as a boy. Early interested in physics, he undertook the study of medicine rather than pure science because it was his only opportunity to get an education in at least a related field without forcing pecuniary sacrifices on his parents, who had to take care of five boys. He entered the army medical school in Berlin and served for some years after graduation as an army surgeon. In Ber-