Herbert Spencer's influence on the genesis of Sherrington's concept of the integrative action of the nervous system

In the early beginning of the 20th century, a new "vision" of how the nervous system functions was put forward by Sir Charles Scott Sherrington (1857-1952), a founding father of modern neurophysiology. His concept of the integrative action of the nervous system became the new credo, a source of inspiration and reference. A contemporary of Sherrington, Herbert Spencer (1820-1903) had through his thoughts and works a seminal influence on the works which preceded those of Sherrington. The concept of the integrative action of the nervous system proposed by Sherrington can be seen in a broader context when one takes into account the relations between Spencer, the British philosopher, and Sherrington, his fellow-countryman, also a philosopher.¹

Herbert Spencer was born in Derby, England, on April 27, 1820. His father, William George Spencer, was a schoolmaster. His later ideas of nonconformity were inspired by his parents. He was an avid reader, particularly in the natural sciences. He was mostly an autodidact. For a brief period a schoolteacher, he became in 1837 a railway engineer. He worked on the Birmingham and Gloucester railway until its completion in 1841.

In 1848, Spencer became a subeditor of the Economist, a position he left in 1853. In 1851, he published Social Statics, where he describes progress as "not an accident but a necessity". His Synthetic Philosophy comprised the following books: First Principles (1862), rev. ed. (1900); The Principles of Biology, 2 vol. (1864-1867), rev. ed. (1898-1899);
The Principles of Psychology, 2 vol. (1855, 1872), 4th ed. (1899); The Principles of Sociology, 3 vol. (1876-1896); and The Principles of Ethics, 2 vol. (1892-1893). His other works include: Essays: Scientific, Political and Speculative, 3 series (1857-1874), final ed. 3 vol. (1891); Education: Intellectual, Moral, Physical (1861); The Study of Sociology (1873); The Nature and Reality of Religion (1885), withdrawn from publication; Facts and Comments (1902). The two volumes of his Autobiography were published posthumously, in 1904.

Spencer died on December 8, 1903, at Brighton.²

In the second half of the nineteenth century Spencer's work was considerable. His fields of study were as diversified as biology, psychology, or sociology.³ His influence in the genesis of the theory of evolution is not questioned.⁴ He created the expression "the survival of the fittest".⁵ The influence of Spencer and his theories was felt not solely on his contemporaries but also, in a tangible manner, up to the beginning of the twentieth century.⁶ He was described as "one of the most argumentative and most discussed English thinkers of the late Victorian period".⁷ To view accurately Spencer's place in his era, consider some of the personalities close to him: Thomas Henry Huxley (1825-1895), the friend and successor of Charles Robert Darwin (1809-1882), the Irish physicist John Tyndall (1820-1893), or Sir Joseph Dalton Hooker (1817-1911), a physician and botanist.⁸ Parallels between Spencer and Lord George Gordon Byron (1788-1824), Jean-Jacques Rousseau (1712-1778) or Count Lev (Leo) Nikolaevich Tolstoi (1828-1910) have been drawn.⁹ Spencer had partisans. Huxley and Hooker, mentioned earlier, may be counted amongst them.¹⁰ On the other hand, Spencer faced opponents such as the German philosopher Friedrich Nietzsche (1844-1900).¹¹ Spencer's notable influence cannot be restricted to the human sciences. It is perceptible, in the works of the British neurologists John Hughlings Jackson (1835-1911) and Sir David Ferrier (1843-1928).
Attached to Spencer's name is an original vision of the Universe, Evolutionism. It has been defined as the sole philosophical synthesis at the end of the nineteenth century. Spencer's leading idea can be summarized as follows: the conservation of force involves a purely mechanical law of evolution, namely, integration of matter, dissipation of matter, dissipation of motion, transition from simple to compound, from homogeneous to heterogeneous. Dissolution ensues necessarily the final stage of integration, according to Spencer. In his theory, evolutions and dissolutions might succeed one another, in alternate manner and infinite duration.

Charles Scott Sherrington was born on November 27, 1857, at Islington (London). He started his medical studies at Edinburgh, but transferred soon to Cambridge, to be closer to his brother. In 1884, he published his first scientific paper, on one of Goltz's [Friedrich Leopold Goltz (1834-1902)] decorticized dogs. During the winter of 1884-1885, Sherrington worked for a time in Goltz's Physiological Institute at Strasbourg, France (once more in 1895). In 1885, Sherrington became a member of the Royal College of Surgeons. The same year, he was part of an investigative team sent by the Royal Society to inquire about the outbreak of Asiatic cholera in Spain. It was during this mission that he became a friend of Ramon y Cajal (1852-1934).

During the winter of 1885-1886, Sherrington returned to physiology at Cambridge. Later in 1886, he went to Italy on another mission of investigation on the outbreak of Asiatic cholera. He spent more than a year, afterwards, in Germany working, for a short while, in Virchow's [Rudolf Ludwig Karl Virchow (1821-1902)] laboratory, and mainly with Robert Koch (1843-1910). He followed the lectures of Waldeyer [Heinrich Gottfried Wilhelm Von Waldeyer-Harz (1836-1921)] in Berlin.

In 1887, he became Lecturer in Physiology at St. Thomas's Hospital, in London. In 1891, he was professor-superintendent at the Brown Insti-
tution, a veterinary hospital of the University of London. He was appointed Professor of Physiology at Liverpool in 1895. He assumed the chair of physiology at Oxford in 1913. Together with Edgar Douglas Adrian (Lord Adrian) (1889–1977), he was Laureate of the Nobel Prize in Physiology and Medicine for 1932. He died on March 4, 1952, at the age of ninety-five. 17

The concept of integration was introduced in biology by Spencer as early as 1855, in his work The Principles Of Psychology. Piotr K. Anokhin (1898–1974) gives credit to Spencer for this introduction, without being too specific about the matter. 18

Although no mention can be found in the literature, in The Principles Of Psychology (1855), Spencer introduced the concept of integration in neurology. He developed it, treated it at greater length, in The Principles Of Biology (1863–1867). Taken from The Principles Of Psychology the following lines make our point more explicit:

Meanwhile these centres in which molecular motion is liberated, are also the centres in which it is co-ordinated; and the successively higher and larger centres which evolve successively larger quantities of molecular motion, are also centres in which successively more complex co-ordinations are effected. Whence follows the general result that along with each further development of the nervous system, enabling it to make all parts of the body work together more efficiently in simultaneous and successive actions, there goes an increased power of evolving the energy required for such larger aggregates of actions. [...] In the functions of the successively-higher vertebrate centres, reaching their climax in the human being, we see well exemplified the law of development of functions in general (First Principles, Part II. § 142). This progress from co-ordinations that are small and simple to those that are larger and compound, and to those that are still larger and doubly compound, is one of the best instances of that progressive integration of motions, simultaneously becoming more heterogeneous and more definite, which characterizes Evolution under all its forms. 19

In The Principles Of Biology, Spencer described physiological integration by the nervous system:
Another and higher form of physiological integration in animals, is that which the nervous system effects. Each part as it becomes specialized, begins to act upon the rest not only indirectly through the matters it takes from and adds to the blood, but also directly through the molecular disturbances it sets up and diffuses. Whether nerves themselves are differentiated by the molecular disturbances thus propagated in certain directions, or whether they are otherwise differentiated, it must equally happen that as fast as they become channels along which molecular disturbances travel, the parts they connect become physiologically integrated, in so far that a change in one initiates a change in the other.

The concept of the integrative action of the nervous system became firmly established in the writings of Sherrington (set forth in the course of the Silliman Lectures in 1904 at Yale University), published in his famous work *The Integrative Action Of The Nervous System* (1906). Sherrington defined the integrative action of the nervous system as follows:

In the multicellular animal, especially for those higher reactions which constitute its behaviour as a social unit in the natural economy, it is nervous reaction which par excellence integrates it, welds it together from its components, and constitutes it from a mere collection of organs an animal individual.

The fabric of the concept of the integrative action of the nervous system was termed "revolutionary" by Swazey (1968, 1969):

From this study, using the nerve cell and its interconnections as his basic analytical unit, he in turn wove the revolutionary fabric of the integrative action concept.

Yet, rightly, she asserts that the idea of nervous integration did not appear de novo with Sherrington's work:

The idea of nervous integration did not originate de novo with Sherrington. The fact of motor coordination and the participation of the nervous system in its operation had been recognized since antiquity, and prototypes of the integrative action concept may be unearthed from the ancient idea of "sympathy" through Pierre Flourens' studies of how specific brain regions effect an animal's functional unity.
She recalls the work of Jean-Marie-Pierre Flourens (1794-1867), as did before likewise Granit (1966). On the other hand, she describes the innovating character of Sherrington's concept:

The significance of Sherrington's concept lies in the fact that it provided the first comprehensive, experimentally documented account of how the nervous system, through the unit mechanism of reflex action, produces an "integrated", or "coordinated", motor organism.25

To understand Sherrington's writings, one must consider the works which preceded them. Sherrington's explicative diagram, he insisted, did not differ much from Descartes's diagram: "animal spirits" were replaced by "nerve impulses".26 Nevertheless, there was an important difference: the mechanism was shifted from the muscles to the spinal cord, or, in other terms, from the periphery into the central nervous system.27 The experimental approach of Sherrington and Pavlov, according to Konorski (l967), was similar: Pavlov emphasized the cortical processes, while Sherrington accentuated more the spinal functions.28 Ivan Petrovich Pavlov (1849-1936) acknowledged Spencer's influence on the understanding of physiology:

Physiology is indebted to the English philosopher Herbert Spencer for having been the first to express the thought that these reactions [instincts] are also reflexes.29

A careful scrutiny of Spencer's Autobiography (1904) reveals it contains no allusion to Sherrington. However, Sherrington had acquaintance of Spencer's work. Indeed, in The Integrative Action Of The Nervous System (1906), he quotes Spencer's general concept of integration:

Here it is that we see eminently what Herbert Spencer has insisted on, namely, that integration keeps pace with differentiation.30

This excerpt is not unique. With regard to the phenomenon of fear and its physical expression, Sherrington mentions Spencer's ideas:

Herbert Spencer wrote: "Fear, when strong, expresses itself in cries, in efforts to hide or escape, in palpitations and tremblings;
and these are just the manifestations which would accompany an actual experience of the evil feared. The destructive passions are shown in a general tension of the muscular system, in gnashing of the teeth and protrusion of the claws, in dilated eyes and nostrils, in growls: and these are weaker forms of the actions that accompany the killing of prey." In short, the bodily expressions of emotion are instinctive actions reminiscent of ancestral ways of life.

Sherrington reports Spencer's views on the cerebellum and the cerebrum:

Spencer suggested that it was [the cerebellum] the organ of co-ordination of bodily action in regard to space, the cerebrum he suggested being the organ of co-ordination of bodily action in respect of time.


Studies on Sherrington and his work have been published recently (Granit, 1966; Swazey, 1968, 1969; Eccles and Gibson, 1979). Spencer has been totally ignored. No one has observed that Sherrington recalled Spencer's concept of integration in The Integrative Action Of The Nervous System (1906). As a matter of curiosity, in Charles Scott Sherrington: An appraisal (1966), Granit, Sherrington's disciple, does not mention Herbert Spencer. The Spencer he speaks about is our contemporary, William Alden Spencer.

Herbert Spencer had an unquestionable influence on John Hughlings Jackson. In An Autobiography (1904), the only Jackson gusted by Spencer is a colleague engineer... Canguilhem (1963) recalls:

Hughlings Jackson (1835-1911), interpreting analogous observations from Spencer's Evolutionism postulates, introduced in neurology the concept of a conservative integration of structures and functions, the less complex of which are dominated and controlled at a superior level by the more complex and differentiated ones, which have appeared subsequently in the order of phylogenesis (1864, 1884).

Hécaen and Lanteri-Laura (1978) underline:
Thus, we must at present understand the way two Anglo-Saxons, D. Ferrier and H. Jackson, were able, at one and the same time, to remain the heirs and the continuators of associationism through Bain, S. Mill and H. Spencer, and to contribute in a very original manner to the theory of cerebral localizations.

So deep were the influences of the theories of Bain [Alexander Bain (1818-1903)] and Spencer on the work of Jackson and Ferrier, that it was possible to affirm the latter can be deduced from the first, without exaggerating too much.

Jackson acknowledged that his clinical work was an application of the conceptions of Bain and Spencer; Ferrier took the same stand, about his experiment. Jackson admitted that his work "is nothing else but a simple application of H. Spencer's certain principles as they are established in his psychology.

Jackson was attracted at first by philosophy, due to Spencer's work, before finding his way to medicine. Spencer's evolutionary philosophy influenced the clinical thought of Jackson:

Inspired by the evolutionary philosophy of Herbert Spencer, John Hughlings Jackson (1884) developed a theory that "dissolution" (degeneration) follows a course inverse to that of evolution. According to this theory, the entire nervous system in disease is exposed to a noxious influence, but the highest centers, being phylogenetically newest, are the least resistant. Jackson also hypothesized that after destruction of a cerebral center some symptoms resulted from the overaction of other structures released from the influence of the destroyed center.

As Jackson recognizes Spencer's influence, Ferrier states what he owes to Jackson. Moreover, Ferrier acknowledged his indebtedness to Spencer. His experiments, he claims, have given a physiological basis to the conceptions of Bain and Spencer. John Hughlings Jackson (1835-1911) was interested in nervous physiology and pathology. He demonstrated that certain cerebral regions apparently controlled certain movements of the limbs. Taking pathology as a basis, Jackson drew the chart of normal functions. He had foreseen the existence
of a motor region in the cortex.\textsuperscript{50} Sherrington's concept of the integrative action of the nervous system had already been promoted in Jackson's work.\textsuperscript{51} Steiner (1982) writes:

By the year 1875, Hughlings Jackson was able to state clearly the concept of integration at various levels of the central nervous system, up to the cerebral cortex.\textsuperscript{52} According to Melville (1982): "Jackson remains the father figure of British neurology...".\textsuperscript{53}

Sir David Ferrier (1843–1928) had a profound influence on neurology, at the end of the nineteenth century and the beginning of the twentieth century.\textsuperscript{54} He laid the foundations of the theory of localization of cerebral functions.\textsuperscript{55} On the basis of experimental and clinical evidence, Ferrier assigned certain functions to specific hemispherical areas.\textsuperscript{56} Thus, Sherrington could say about Ferrier: "He established the localization of the motor cortex very much as we know it."\textsuperscript{57}

In 1876, Ferrier dedicated his work \textit{The Functions Of The Brain}, to Jackson. In this work, the idea of integration can be found, although not yet developed to the extent of forming a system.\textsuperscript{58} Sherrington dedicated his \textit{The Integrative Action Of The Nervous System} (1906) to Ferrier. "To Sherrington", as writes Granit (1966), "David Ferrier was something of an idol."\textsuperscript{59}

Rothschuh (1973) underlines:

His interest [Sherrington's] in the nervous system was awakened by the studies of Sir David Ferrier (1843–1928) entitled \textit{The Function [sic] of the Brain} (London, 1876).\textsuperscript{60}

Ferrier is the mediating link between Sherrington and Jackson.\textsuperscript{61} And according to Gibson (1982):

From Jackson to Ferrier to Sherrington, a current of thought and of endeavor "runs deep". Much of it concerns localization of cortical function.\textsuperscript{62}
Although it is difficult to support by tangible evidence, or by written testimony, or by mention of a recognized influence from Spencer, or in Sherrington or in any of his near relations, Spencer's influence is much more than a historical assumption. Spencer was the first to formulate a theory of nervous integration. This important fact has escaped the attention of those who have analysed nervous integration. A plausible explanation for this failure: influences Sherrington came under were not thoroughly studied or dissected. The reading of facts was too conventional and limited. Such reading appears inadequate. The Ariadne's clew leading from Spencer to Sherrington certainly exists. We have unravelled the direct and indirect influences of the thoughts and works of Spencer on Sherrington himself. Spencer's work must be seen as related to the genesis of the concept of the integrative action of the nervous system, the classical concept of contemporary neurophysiology.

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NOTES

1. In 1931, in Bern, the title of "the philosopher of the nervous system" was granted to Sherrington; see J.F. Fulton, "The Nobel Prize in Physiology and Medicine. Sir Charles Scott Sherrington," Sci. Monthly, 1932, XXXV: 569. See also A.D. Ritchie, "Sherrington As Philosopher," Br. Med. J., 1947, 2: 812-813. Sir John C. Eccles and William C. Gibson, Sherrington: His Life and Thought (Berlin-Heidelberg: Springer Int., 1979), p. IX, observe: "From 1933 until his death in 1952 Sherrington was dedicated to the philosophy of the central nervous system. He rightly sensed that it was the greatest problem, both scientific and philosophical, confronting man."


10. On the relations between Spencer and Huxley, see Hugh Elliot,


14. Ibid.


16. Ibid.


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the fourth edition...


23. Ibid.


27. Ibid.


31. Ibid., p. 258.

32. Ibid., p. 348.

33. Ibid., p. 393.


41. *Ibid."


43. Lawrence C. McHenry, Jr., *Garrison’s History of Neurology* (Springfield, Illinois: Charles C. Thomas Publisher, 1969), p. 307. The name of Spencer is rendered under the unusual form of Spenser (pp. 307, 539)...


52. T.J. Steiner, "Development of the Concept of Supraspinal Control", in F. Clifford Rose and W.F. Bynum, eds., _op. cit._, 1982, p. 37.


56. _Ibid_.

57. _Ibid_.

58. Sir David Ferrier, _The Functions Of The Brain_, (London: Smith, Elder, 1876; Reprinted, London: Dawsons Of Pall Mall, 1966), pp. 214, 294. The expression found is "integrated".


