'Autonomic' Nervous System

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From the *Oxford English Dictionary*: 'autonomic' is the adjective derived from 'autonomy' meaning self-governing or independent [1]. With respect to physiology, autonomic nervous system is that part which functions independently of the will. John Newport Langley (1852–1925), the Cambridge physiologist, first applied the term in 1898 in a paper in the *Journal of Physiology*: 'The autonomic nervous system means the nervous system of the glands and of the involuntary muscle ... I propose the term autonomic nervous system for the sympathetic nervous system and the allied nervous system of the cranial and sacral nerves, and the local nervous system of the gut' [2].

The concept that an independent part of the nervous system coordinates body functions had its origin in the works of Galen (129–199), who proposed that nerves distributed spirits throughout the body. From animal dissections he concluded that there were extensive interconnections from the spinal cord to the viscera and from one organ to another. He proposed that this system fostered a concerted action or 'sympathy' of the organs. Little changed until the Renaissance when Bartolomeo Eustachio (1545) depicted the sympathetic nerves, the vagus and adrenal glands in anatomical drawings. Jacobus Winslow (1669–1760), a Danish-born professor working in Paris, popularised the term 'sympathetic nervous system' in 1732 to describe the chain of ganglia and nerves which were connected to the thoracic and lumbar spinal cord [3].

The functions of this system were elucidated in a series of important physiological experiments in the second half of the 19th century. Ernst and Eduard Weber in Leipzig stopped the heart by stimulating the vagus nerve whilst Claude Bernard and others reported the acceleration of the heart's action with sympathetic stimulation. These opposing actions led Walter Gaskell [4] at Cambridge to conduct a series of experiments on heart physiology to conclude that the 'involuntary system' was composed of two antagonistic subsystems. Following reports by Oliver and Schäfer [5] in 1895 about the potent effects of adrenal gland extracts, research was focused on identifying 'the active principle'. John Jacob Abel [6] working at Johns Hopkins in 1897 isolated a benzoyl derivative from crude adrenal extracts which he called 'epinephrin'. He followed the suggestion of Josef Hyrtl, professor of anatomy at Vienna, that 'epinephris' was the best name for the suprarenal capsule. Hyrtl [7] preferred Greek to Latin, quoting Molière: 'Parce qu'avec du grec on a toujours raison'. Jockichi Takamine [8] working in New York and sponsored by Parke Davis and Co. isolated the active principle in pure form and coined the term 'adrenalin'. His colleague Thomas Aldrich successfully deduced its chemical structure and adrenalin became a trademarked name for Parke Davis. Subsequently scientific reports in American journals have used the term introduced by Abel, 'epinephrine' whereas European journals have used 'adrenaline'.

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Gaskell's colleague and successor at Cambridge was John Newport Langley, who continued experimental work in the physiology laboratories and made a number of seminal discoveries. He gave the autonomic nervous system its name replacing 'vegetative nervous system' of Johann Christian Bell and Francois-Xavier Bichat's 'ganglionic nervous system'. He established that the autonomic nervous system had central and peripheral components although his research was confined to the peripheral nerves and end organs. He suggested the presence of synaptic connections on smooth muscle and secretory glands.

Langley accepted the antagonistic subsystems of Gaskell. He applied Winslow's term 'sympathetic' to the division that had its cell bodies in the lateral horns of the thoracic and lumbar spinal cord. For the cranial and sacral divisions of the autonomic nervous system which were involved in visceral innervation he coined the term

'parasympathetic'. He also introduced the terms 'pre-ganglionic' and 'post-ganglionic' and made important observations on the functions in the circulation, heart, smooth muscle and abdominal viscera. Langley was a mentor to students at Cambridge including Thomas Elliott, Henry Dale and Charles Sherrington, who made major contributions to neuroscience in the early 20th century.

'Autonomic nervous system' is part of the neurologic vocabulary and has been adapted for the nomenclature of its medical disorders. Dysautonomia or dysautonomic is the general term for diseases involving this system whilst pandysautonomia or panautonomic neuropathy is a syndrome of acute autonomic paralysis [9]. The pioneering work of John Langley was foundational to our understanding of this system and the terminology in current use.

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