Central and Peripheral Interrelations between Blood Pressure Control Mechanisms

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Abstracts

THE VISCERAL NERVOUS SYSTEM (VNS): HOMEOSTASIS AND THE DISSIPATIVE STRUCTURE

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Since the work of W. B. Cannon, the concept of reflex regulation of visceral function has usually been associated with that of negative feedback regulation for the purpose of Homeostasis. Homeostasis has been used to indicate either the constancy, inside a physiological range of the measured variable, and either the deterministic organization of function, necessary to survival, despite the threatening environmental stimuli. This term implies a mechanical, physical model of reference. Although the contradictory aspects of Cannon's Homeostasis and Emergency theories have been previously discussed (Recordati G., Arch. It. Biol. **122,** 1984), this critique may be further pursued: 1) Of the two regulatory systems, endocrine and nervous system, we now know that the constancy of the fluid matrix is first of all guaranteed by the metabolism and the endocrine system. Examples are: the constancy of body temperature, glycemia, natremia and acid-base balance. 2) The concept of reflex regulation needs to be uncoupled from that of the feedback regulation and the linear causality, between stimulus and response, that it implies. Between the regulated variable and the stimulus on the sensory component, there is a multiplicity of interposed events which make the "circular causality" the most reasonable description of a biological causality (Yates F. E., In: Self-organizing systems, p. 347-350, Ed. F. E. Yates, Plenum, 1987). Some of the organizational principles which characterize the VNS's function and that distinguish it from the endocrine system and Homeostatic theory are: 1) The biological system is an open system which exchanges ENERGY, MATERIAL and INFORMATION with its environment. The nervous system in general and the VNS in particular is the apparatus which allows the biological system to be open to the environment: it is the interface between outside and inside environment. 2) This interface, which possesses a high degree of complexity in its internal organization, is characterized by plasticity and dynamicity of function, both at the peripheral and at the central level. Plasticity is maximal in embrionic and early life, but persists in adulthood (Black I. B. et al, Science **225,** 1984). 3) The concept of the nervous center is now being substituted by that of the dynamic central regulation of function. 4) The VNS's development of internal functional organization is dependent on its relationships with the external and internal environments: the VNS keeps its internal organization as a function of the stimulus. The physical model which may be used to describe these organizational principles is that of the thermodynamics of non-equilibrium, i. e. the DISSIPATIVE STRUCTURE of I. Prigogine (Science **201,** 1978). From this point of view, the function of both the sympathetic (SNS) and parasympathetic (PSNS) systems will be to use free energy to do work. If thermodynamic equilibrium is taken as reference, the SNS will then move the visceral system far away from equilibrium, and the PSNS towards it. While the SNS will be mainly related to the exchange of energy and increase gradients, the PSNS will be mainly related to the exchange of material and decrease gradients. The term information originates during phylogeny and may be described as the result of a relational constrain on the dynamic and unstable behavior of the system: the new structure exhibits a pattern which is stable with respect to the chance events of the previous level. Instability is thus a necessary condition for the appearance of information-dependent behaviors (Pattee H. H., In: Self-organizing systems, p. 325-338, Ed. F. E. Yates, Plenum, 1987). This hypothesis, which is a reproposal of the ergotropic-trophotropic theory of W. R. Hess, allows to include both Homeostasis, as the description of a simplified system near equilibrium, and the Emergency theory, as the description of a complex system far away from equilibrium. It may also help to explain other hypothesis so far formulated and apparently contradictory, such as the "Pattern of response" of S. M. Hilton, and the "Dynamic specificity" of P. Langhorst. The mechanical model of the Homeostatic theory, does not allow, instead, this integrative approach. Despite their limits, teleology for Homeostasis and epistemological reductionism for the Dissipative Structure, it is suggested that, by the mean time, both theories might be complementary used to attempt a comprehensive view of the function of the VNS.