J. Physiol. (Paris) 93 (1999) 261

Information processing in the axonal tree: New issues

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The axon conveys information, in the form of action potentials assumed to be generated at its initial segment, to the different targets of the neuron: is it a reliable line faithfully transmitting the same information to all terminals? This question was raised as early as the fifties. Krnjevic and Miledi (1958) demonstrated that action potentials could fail to propagate on intramuscular branches of motor axons. Later on, Henneman suggested that, in the central nervous system, the axonal electrotonic architecture was responsible for conduction blocks at branching points, but experimental evidence for such failures remained scarce and debated. Recent experimental and theoretical data suggest that several mechanisms can selectively filter the transmission of information along axons. For instance the activation of some voltage-dependent conductances or ligand-gated synaptic conductances can dynamically change the non-linear properties of the axonal membrane, reshape action potentials and affect their propagation. Axonal information processing, now demonstrated on invertebrate and vertebrate preparations, is changing our view of what computations are performed at the single neuron level and has important consequences on the functional properties of neural networks. The emergence of this new vision of the axon, as an information processing device, prompted the organization of an international meeting '*Information processing in the axonal tree: new issues*', held in Paris, April 2–3, 1998, at Université René Descartes.

Participants to this meeting, experimentalists and theoreticians, were invited to contribute to this special issue of the *Journal of Physiology (Paris)*. The general mechanisms of information processing in axons are introduced in chapter 1. Influence of geometry on axonal processing (chapter 2), of A-like potassium conductances (chapter 3) and of the functional type of neuronal targets (chapters 4 and 5) are then discussed. Chapter 6 reviews the functional consequences of axonal information processing in invertebrate. A large part of this volume is devoted to presynaptic inhibition of afferent fibres: chapter 7 is a brief historical review by P. Rudomin of presynaptic inhibition in mammals. The mechanisms and functions of presynaptic inhibition are then discussed in invertebrates (chapter 8), neonatal rats (chapter 9), adult mammals (chapter 10) and humans (chapters 11–13).

The organizers wish to thank Pr. Lassau who generously allowed us to use the conference room of the Anatomical Institute of Université René Descartes, Mrs. Martine Escoute for her skilled assistance in the organization of the meeting, Dr. Yves Frégnac, the Editor of these proceedings for the *Journal of Physiology (Paris)* and Miss Gabrielle Regnoni for editorial assistance.