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Multimodal signal integration in the nervous system: from ion channels to neurons to networks - and reverse.[1]

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Signal encoding in single neurons and neuronal nets can drastically change depending on their actual dynamical state. Dynamic state transitions are of particular relevance when different types of signals have to be simultaneously integrated because each signal can modify the transduction characteristics of each other signal due to the system's inherent non-linearities. Nonlinear, multimodal signal encoding can already be seen at the single neuron level [Braun et al. 1994, Nature 367: 270-273] and is an essential characteristic of integrative brain functions [Wollweber et al. 2004, J Thermal Biol, 29: 345-350]. However, signal encoding and neuromodulation takes place at a still lower level, namely by alterations of voltage- or ligand-gated ion channels. Nevertheless, to avoid an overwhelming complexity, the dynamics at the lower levels are often neglected when higher levels are examined, e.g. neuronal network analysis generally does not consider the details of ion channel gating. Hodgkin-Huxley type computer simulations shall elucidate which simplifications can be made without loss of essential functional properties and which state transitions at lower levels can become of functional relevance for the higher level dynamics [Sosnovtseva et al. 2004, FNL 4:L521-L533].

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