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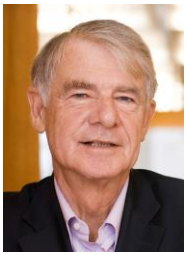

Prof. Dr. Dr. h.c. mult. Wolf Singer studied Medicine in Munich and Paris, obtained his MD from the Ludwig Maximilian University in Munich, and his PhD from the Technical University in Munich. He is Director em. at the Max Planck Institute for Brain Research in Frankfurt, Founding Director both of the Frankfurt Institute for Advanced Studies (FIAS) and of the Ernst Strüngmann Institute for Brain Research (ESI) and Director of the Ernst Strüngmann Forum.

His research is focused on the neuronal substrate of higher cognitive functions, and especially on the question how the distributed sub-processes in the brain are coordinated and bound together in order to give rise to coherent perception and action. These studies are performed with electrophysiological techniques in behaviorally trained monkeys and with non-invasive imaging methods in human subjects.

The encoding of semantic relations

A prominent function of the brain is the generation and continuous updating of an internal model of the world. This requires extraction of relevant features, the detection and encoding of meaningful relations among them and the storage of this information in a rapidly accessible format. The information provided by this model, addressed as prior expectations in the framework of Bayesian computation, is used to reduce redundancy, to facilitate segregation of figures from background, to bind signals evoked by features constituting a perceptual object, to permit classification and to formulate predictions. The store containing such an elaborate model must have an immense capacity in order to accommodate the vast number of priors required for the interpretation of ever changing sensory input patterns and read out of specific priors needs to be achieved within fractions of a second. It is proposed that these constraints can only be met if information is encoded and computations are taking place in the high dimensional state space provided by complex systems with non-linear dynamics. It is suggested that neo-cortex, because of its unique recurrent connectivity, can provide such a space. A concept is proposed that attributes distinct functions to features of network dynamics that so far play only a minor role in current theories on cortical information processing. These features comprise changes in the correlation structure, entropy and dimensionality of distributed activity, network oscillations, synchronisation phenomena and phase shifts.

The proposed computational strategy is likely to account for a number of hitherto poorly understood functions: The encoding of temporal sequences, the storage of vast amounts of information about the environment in the networks of sensory cortices, the ultrafast retrieval of this information in processes requiring comparison between input signals and stored knowledge and the fast and effective classification of spatio-temporal input patterns.

The core of the hypothesis is that i) cortex exploits for its computations the high dimensional state space that is provided by the non-linear dynamics of delay coupled recurrent networks, ii) information is stored in the weight distributions of the recurrent connections and iii) semantic relations are encoded not only in the responses of conjunction specific nodes but also in the temporal correlation structure of high dimensional response vectors. This hypothesis will be discussed in the context of differences between Eastern and Western concepts regarding relational constructs.