Understanding the role of dendrites in cortical information processing

Results:

We developed several neural network models based on dendritic computation. Dendrites as independent computational units enable simulation of wide variety of perceptual and cognitive phenomena. Computer simulations showed that new neural networks with dendrites are able to explain how neural activity is modulated by attention in primary visual cortex and in extra-striate cortex. Also it was shown how visual search is performed among moving targets and for targets that change locations due to the eye movements. The model of the interaction between dorsal and ventral visual streams enabled simulation of classical Gestalt principles of figure-ground organization (size, contrast, and convexity) along with newly discovered principles such as lower region and top-bottom polarity. The same model of figure-ground organization produced brain activation consistent with brain imaging studies and with electrophysiological recordings in the monkey brain. The model of temporal grouping is able to explain how we segregate figures from background based on temporal changes alone. This model does not require neural synchronization in order to sense temporal patterns. Furthermore, we developed a neural model of semantic memory which is able to simulate recent experimental findings about interaction between language understanding and perception and action. We performed several cognitive experiments which showed that perceptual and motor variables facilitate semantic processing in agreement with the model. Our project provided computational evidence for the importance of dendrites for information processing in the nervous system and for understanding visual perception and cognition.

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Areas of interest:

Computational modeling, cognitive neuroscience, neural networks, visual perception, conceptual processing

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