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Brain Mechanisms of Vision: A Combined Approach Using Psychophysics, Modeling and Electrophysiology

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Abstract

We perceive scenes and 3D images so easily that we could simply underestimate the complexity of the brain visual system. Many areas of brain are dedicated to visual processing. A review of the involved areas in vision shows they are specialized for distinguished aspects of a visual stimulus, like form, motion, color, etc. One of the oldest approaches to the visual system is to create and interpret visual illusions to uncover the tricks used by brain. The visual system implements many heuristics to handle a scene. Visual illusions, which are sometimes used as a tool for entertainment, are actually very efficient tools to investigate such heuristics. At the same time, they can reveal visual system limitations and unexpected properties. Here, I briefly review different anatomical visual areas, their functions and microstructure, and present a few examples of illusions, how they can lead to certain hypothesis of possible connectivity of brain cells (neurons), and a modeling suggestion. Then, I review how the model can directly be tested by single cell recording using spike triggered cross-correlation. At the end, I summarize the interplay between psychophysics experiments, modeling approach and electrophysiology for a better understanding of visual system.

Bio

Arash Yazdanbakhsh received his M.D. from Tehran Medical University in 1998. After graduation he both practiced medicine and served as a research fellow at the School of Intelligent Systems in the Institute for the Study of Theoretical Physics and Mathematics. Following his long term interest in the brain mechanisms behind visual processes he entered in the doctoral program at the Department of Cognitive and Neural Systems at Boston University in 2001 and earned his PhD in 2005. His doctoral thesis incorporated both psychophysical experiments and a computational model of surface and contour perception. He is currently serving as a post doctoral research fellow in Margaret Livingstone's lab at Harvard Medical School studying the single cell electrophysiology in the primate visual system. In 1996 he co-founded and co-directed the NODET-Neuroscience Center in Tehran, was a visiting fellow in the Institute of Higher Nervous Systems, State University of Moscow, and a visiting fellow at the Pavlov institute of Physiology, National Academy of Science, St. Petersburg. Alongside Stephen Grossberg at Boston University he researched and developed laminar cortical models of visual processing in primary visual and extra-striate cortex of the brain. Since 2004 he has participated in multiple peer reviews of ongoing research and models of the visual system. He has served as a reviewer of several journals and conferences including Cognitive Psychology Journal, Vision Research, Journal of Vision, Experimental Psychology Journal, IEEE Transactions on Systems Man and Cybernetics, Journal of the Optical Society of America, and at the International Joint Conference on Neural Networks. Since 2002 he has been a Member of Vision Sciences Society, Society for Neuroscience, and International Neural Network Society. He is a visiting scholar in the Psychology Department of Boston University and is currently collaborating with Takeo Watanabe and Ennio Mingolla in the Psychophysics Lab at Boston University.

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