Universal pattern selection in the visual cortex

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In the cortex of the mammalian brain, visual information is processed by a complex 2-dimensional pattern of functional modules called the orientation preference map. Because in young animals this structure is thought to arise by the dynamics of neuronal learning mechanisms, a central aim of current research is the identification of dynamical models that can quantitatively reproduce its spatial organization [1-3].

To provide a firm basis for comparing experimental observations and the predictions of models of neuronal self-organization, we recently characterized the spatial statistics of singular points in orientation preference maps in a wide variety of animal species including monkeys, carnivores, and shrews. In particular, we studied the spatial density of singular points, their count variance, and the next neighbor distance distributions of singular points. Surprisingly, we found that all of these basic statistics are quantitatively indistinguishable, i.e. universal in the species studied [4]. This is in sharp contrast to the fact that they have been separated for more than 50 million years of evolution, occupy different ecological niches, and exhibit distinct patterns of visual behavior. Theoretical analyzes show that the observed universal statistics are quantitatively reproduced by models of cortical self-organization dominated by long-range interactions [3-4]. We conclude that the experimentally observed universal statistics are emergent signatures of a dominant role of long-range interactions in the self-organization of cortical neuronal circuits.

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