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Columnar organization of orientation domains in V1 JOSCHA LIEDTKE, FRED WOLF, Max Planck Institute for Dynamics and Self-Organization — In the primary visual cortex (V1) of primates and carnivores, the functional architecture of basic stimulus selectivities appears similar across cortical layers (Hubel & Wiesel, 1962) justifying the use of two-dimensional cortical models and disregarding organization in the third dimension. Here we show theoretically that already small deviations from an exact columnar organization lead to non-trivial three-dimensional functional structures. We extend two-dimensional random field models (Schnabel et al., 2007) to a three-dimensional cortex by keeping a typical scale in each layer and introducing a correlation length in the third, columnar dimension. We examine in detail the three-dimensional functional architecture for different cortical geometries with different columnar correlation lengths. We find that (i) topological defect lines are generally curved and (ii) for large cortical curvatures closed loops and reconnecting topological defect lines appear. This theory extends the class of random field models by introducing a columnar dimension and provides a systematic statistical assessment of the three-dimensional functional architecture of V1 (see also (Tanaka et al., 2011)).

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