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Rhythm-Induced Spike-Timing Patterns Characterized by 1D Firing Map JAN ENGELBRECHT, RENNIE MIROLLO, Boston College — A basic problem in neuroscience is to understand how the dynamic mechanisms that govern the responses of nerve cells to stimuli, which are both non-linear and noisy, still produce reliable collective activity. We study patterning in the responses of neurons subjected to periodic rhythms. These patterns are governed by simple, low-dimensional mathematical structures independent of modeling detail. We show both theoretically and in whole-cell recordings that the 1D map generated from successive spike times is such a construct. As expected, the stable periodic points of this 1D map cause a neuron's entrainment or phase-locking to a periodic rhythm. But our work has also revealed a complementary and unexpected patterning in the spike-timing of un-entrained neurons in the form of repeated sequences of reliable spike-phase advances, which cannot be characterized simply as a noisy perturbation near the stable periodic points of the noise-free return map. This new patterning appears to require both noise and a sufficiently steep return map.

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