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The behavioral space of zebrafish locomotion and its neural network model KIRAN GIRDHAR, Univ of Illinois - Urbana, MARIA BENITEZ-JONES, Univ of New Mexico, HA PHAM THI, Hanoi University of Science, MARK NELSON, MARTIN GRUEBELE, YANN CHEMLA, Univ of Illinois - Urbana — How does one describe quantitatively the complex motion of vertebrates? To answer this question, we investigated a model system for vertebrate locomotion: zebrafish swimming. We performed a quantitative analysis of all stereotyped behavioral swimming patterns of zebrafish larvae: spontaneous swimming, escape response to stimulus, and prey tracking. Previous attempts to analyze zebrafish swimming motion quantitatively have imposed many arbitrary parameters. Here, we instead used a parameter-independent method that produces an orthogonal set of "eigen-shapes" of fish backbones to describe swimming motion in a low-dimensional space. We show that a linear combination of only three such "eigen-shapes" is sufficient to describe 97% of zebrafish shapes. Moreover, stereotyped swimming behaviors fall on two low-dimensional attractors embedded in this three dimensional behavioral space. We also show using a two-dimensional correlation analysis that "scoots" and "R-turns," which were previously described as discrete behavioral states, in fact represent extrema in a continuum in this low-dimensional behavioral space. To understand the neural basis of the behavior, we have also developed a neural network model of spontaneous swimming of fish larvae. We present a set of neural parameters such as synaptic conductance, stimulus amplitude that produces swimming behavior and reconstructed the low-dimensional behavioral space obtained from experimental results.

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