SYMBOLIC ANALYSIS REVEALS SCALE INVARIANCE OF FISH TRAJECTORIES AND PROVIDES A NEW MODEL FOR MOTOR BEHAVIOR

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ABSTRACT

We have questioned whether a complex behavior, such as fish swimming, can be better described quantitatively as a sequence of discrete events or states than with classical kinematic measures which can be compromised by inherent variability. Here, the different states, expressed as combinations of symbols, were defined on the basis of the animal's location (A periphery, B inner part of the aquarium) and speed (Fast and Slow). We observed that the distributions of time intervals spent in the successive states were not gaussian. Rather, they were fit by power laws associated with an underlying Lévy-like process which has more long intervals, primarily due to prolonged periods of relative inactivity. Furthermore, our data suggest that the swimming behavior can be attributed to interactions between two intrinsic systems. One is represented by the matrix of transition of probabilities between states and controls their sequential organisation while the second, which is defined by interval distributions, determines the time spent in each state. This kinetic model detects subtle effects of low doses of neuroactive compounds, and identifies their specific locus of action. We propose that this paradigm can be applied to characterize normal behavior and its modifications by genetic or pharmacological manipulations (for details, see Faure et al. Fractals, in press).