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Songbird Respiration is Controlled by Multispike Patterns at Millisecond Temporal Resolution[1] CAROLINE HOLMES, KYLE SRIVASTAVA, Emory University, MICHIEL VELLEMA, COEN ELEMANS, University of Southern Denmark, ILYA NEMENMAN, SAMUEL SOBER, Emory University — Although the importance of precise timing of neural action potentials (spikes) is well known in sensory systems, approaches to motor control have focused almost exclusively on firing rates. Here we examined whether precise timing of spikes in multispike patterns has an effect on the motor output in the respiratory system of the Bengalese finch, a songbird. By recording from single motor neurons and the muscle fibers they innervate in freely behaving birds, we find that the spike trains are significantly non-Poisson, suggesting that the precise timing of spikes is tightly controlled. We further find that even a one millisecond shift of an individual spike in a multispike pattern predicts a significantly different air sac pressure. Finally, we provide evidence for the causal relation between precise spike timing and the motor output in this organism by stimulating the motor system with precisely timed patterns of electrical impulses. We observe that shifting a single pulse by as little as two milliseconds elicits differences in resulting air sac pressure. These results demonstrate that the precise timing of spikes does play a role in motor control.

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