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Effects of Mechanosensory Feedback on the Lamprey Central Pattern Generator

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Mechanoreceptive neurons, called edge cells, on the margin of the spinal cord are known to respond to stretch and provide sensory information directly to the CPG. Although we know edge cells respond to bending of the body, it is not known how their response is used to adjust the CPG rhythm. We perform bending experiments on the lamprey spinal cord in calcium-free saline and record extracellular edge cell responses in the lateral axon tracts. Using various bending angles and velocities, we compare edge cell firing rates in response to different bending stimuli. We see edge cells respond to both bending angle and rate, but with a much stronger response to bending rate. Using standard spike sorting techniques, we have identified units that respond to different types of bending stimuli. To more fully characterize the input-output mapping from bending to edge cell activity, we use low-pass-filtered white noise as the bending signal. Edge cell responses are characterized in the time domain using spike-triggered averages, which are related to impulse response functions (IRFs), and in the frequency domain using frequency response functions (FRFs). Finally, to understand how edge cells would respond during swimming, we apply a sinusoidal bending signal. Edge cell response is phase locked, where the phase depends on the frequency of bending. To completely characterize the edge cell response, we add noise to the sinusoidal bending signal and compute a harmonic transfer function (HTF). This mapping, when converted to the time domain creates a phase-dependent impulse response function that describes the effects of a short perturbation applied during a particular phase of bending. This map can then be modeled as feedback in closed-loop swimming models for the lamprey.