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A COMPUTATIONAL MODEL OF SONG LEARNING IN THE ANTERIOR FOREBRAIN PATHWAY OF THE BIRDSONG CONTROL SYSTEM. K. Doya* and T. J. Sejnowski, Howard Hughes Medical Institute, Salk Institute, PO Box 85800, San Diego, CA 92186-5800.

The birdsong control system has two pathways: the direct pathway [HVc→RA→nXIIts] is involved in motor pattern generation and the anterior forebrain loop [HVc→area-X→DLM→L-MAN→RA] is essential in learning but is not responsible for execution of the motor program. We propose the following hypotheses: 1) L-MAN modulates the synaptic connections from HVc to RA to promote the exploration of motor patterns; 2) area-X provides an evaluation signal for each syllable produced; 3) the synapses in RA are potentiated based on the contingent modulation from L-MAN and the evaluation from area-X. These hypotheses are compatible with the findings from lesion studies and the locations of NMDA receptors in RA. We constructed a computer model of the song control system to examine the above hypotheses. A sound synthesizer with harmonic and noisy sound sources was used as a model of the vocal organ syrinx. RA units with different motor projection and temporal response profiles were driven by HVc units that code syllable sequences. The temporal pattern of motor command was determined by the connection strengths from HVc units to RA units. The reinforcement pathway from area-X to L-MAN modulates the connection strengths to RA based on the estimated error gradient from a previously learned song template. Using a recorded zebra finch song as the template, this learning system achieved 90% accuracy in a spectrographic measure after 200 trials. When a model song was used as the template, it was reproduced with 96% accuracy, a virtual bird offspring. The results confirm that the anterior forebrain pathway could serve as a reinforcement learning system. The model makes predictions for further experiments.