Singing to the Tune of Dopamine. Focus on “Properties of Dopamine Release and Uptake in the Songbird Basal Ganglia”

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The mammalian striatum, the input nucleus of the basal ganglia, participates in sensorimotor functions that include motor control as well as the learning of behaviors and behaviorally relevant cues. A key player in striatal learning is dopamine. When released from mesostriatal axons, dopamine is thought to provide an error or “teaching” signal for learning behaviorally relevant stimuli and habitual behaviors (Gerdenman et al. 2003; Reynolds et al. 2001; Schultz 2002). Song learning in songbirds has become a key model for the study of motor learning in vertebrates and is hypothesized to be analogous to motor learning in mammals. In particular, area X, a component of the avian striatum in the anterior forebrain pathway (AFP), is essential to song learning and adult song plasticity (e.g., Bottjer et al. 1984; Brainard and Doupe 2000). The AFP is the functional analogue of the mammalian direct pathway of the basal ganglia (Farries and Perkel 2002) and processes song-related auditory feedback. Moreover, it is proposed that some component of the AFP generates an error signal that guides the pathway to produce the target song (Brainard and Doupe 2001). The hypothesis that song learning in birds is analogous to motor learning in mammals is supported further by similarities in physiological mechanisms of which the action of dopamine is a key example: as in mammalian striatum, dopamine in avian area X modulates the excitability of the major, spiny cell type and the strength (long-term depression and potentiation) of excitatory inputs to these cells (Ding and Perkel 2002, 2004; Ding et al. 2003).

Now Gale and Perkel add to this growing hypothesis with a study in this issue of the Journal of Neurophysiology (p. 1871-1879) using a technology to explore in real time the release, receptor regulation, and uptake of dopamine in area X. Gale and Perkel reveal that the regulated availability of dopamine in songbird area X shares multiple key features with its mammalian homologue.

Given that the last common ancestor of mammals and birds lived ≈290 million years ago (Kardong 1998), not to mention the fact that song system nuclei are often assumed to be highly specialized, the basal ganglia of birds and mammals share a remarkable number of morphological and physiological traits. For example, like the mammalian striatum, area X has GABAergic projection neurons and putative interneuron populations that are cholinergic or contain nitric oxide synthase or parvalbumin (see Farries and Perkel 2002). These four neuron types all possess electrophysiological features characteristic of their mammalian counterparts (Farries and Perkel 2000, 2002). Intriguingly, a fifth neuron type not found in mammalian striatum nonetheless probably represents a mammalian palli-
REFERENCES


