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Abstract for Harvard Lecture 2015

Dissecting the molecular mechanisms of vocal learning and spoken language

My long-term goal is to decipher the molecular mechanisms that construct, modify, and maintain neural circuits for complex behavioral traits. One such trait is vocal learning, which is critical for song in song-learning birds and spoken-language in humans. Remarkably, although all are distantly related, we found that song-learning birds (songbirds, parrots, and hummingbirds) and humans have convergent forebrain pathways that control the acquisition and production of learned sounds. This convergent anatomy and behavior is associated with convergent changes in multiple genes that control neural connectivity and brain development, of which some when mutated are associated with speech deficits. Non-human primates and vocal non-learning birds have limited or no such forebrain vocal pathways, but yet possess forebrain pathways for learning and production of other motor behaviors. To explain these findings, I propose a motor theory of vocal learning origin, in which brain pathways for vocal learning evolved by brain pathway duplication of an ancestral motor learning pathway. Once a vocal learning circuit is established, it functions similarly as the adjacent motor learning circuits, but with some divergences in neural connectivity. To test this hypothesis, we are attempting to genetically engineer brain circuits for vocal learning. These experiments should prove useful in elucidating basic mechanisms of speech and other complex behaviors, as well as their pathologies and repair.

Suggested readings:

Pfenning AR, Hara E, Whitney O, Rivas MR, Wang R, et al., & Jarvis ED. [Convergent transcriptional specializations in the brains of humans and song learning birds](#). (2014) *Science* 346 (6215): 1333 & online 1256846-1 to -13.

Whitney O, Pfenning AR, Howard JT, Blatti CA, et al., West AE, & Jarvis ED. [Core and region enriched gene expression networks of behaviorally-regulated genes and the singing genome](#). (2014) *Science* 346 (6215): 1334 & online 1256780-1 to -11.

Jarvis ED, Mirarab S, Aberer AJ, Li B, et al., Gilbert MTP, & Zhang G. [Whole genome analyses resolve the early branches to the Tree of Life of modern birds](#). (2014) *Science* 346 (6215): 1320-1331.

Zhang G*, Li C, Li Q, et al., Jarvis ED*, Gilbert MTP*, & Wang J*. *co-corresponding authors. [Comparative genomics reveals insights into avian genome evolution and adaptation](#). (2014) *Science* 346 (6215): 1311-1320.

Petkov CI & Jarvis ED. [Birds, primates, and spoken language origins: behavioral phenotypes and neurobiological substrates](#). (2012) *Front. Evol. Neurosci.* 4(12):1-24.