Biggest Science Stories 2014: Human Speech Similar to Birdsong

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Neuroscience: If asked to make a comparison, most people would say that a human baby is more like a monkey than a songbird. But, when it comes to the ability to make sounds, we share more with songbirds than with our primate cousins.

The zebra finch has an area in the brain similar to the human basal ganglia, which is involved in our language learning. (Maurice van Bruggen)

Humans and songbirds are both vocal learners – animals that can learn to produce complex vocalizations and are capable of imitating the vocalizations of other species. Parrots, for example, are excellent vocal learners, as are dolphins, seals, elephants and some bat species. Nonhuman primates, sophisticated in so many ways, have fairly simple vocal repertoires. Most are unable to exert voluntary control over their larynx or vocal cords. Whereas human babies have an amazing ability to learn to imitate new sounds, vocal plasticity in non-human primates is quite limited.

This year, researchers at Duke University examined regional gene expression, or differences in the relative concentration of various RNAs and proteins, in the brains of a number of different species. These included a number of vocal learners such as humans, songbirds, parrots and hummingbirds, as well as so-called vocal non-learners such as macaque

monkeys, doves and quail.

The researchers found similar patterns of protein synthesis in an area of the human motor cortex that controls the larynx (LMC) and an area of the songbird brain that plays an important role in vocal sound production. Studies of area RA (robust nucleus of the arcopalladium) show that neurons in this area connect to cells that directly control the bird's vocal organ, or syrinx. Neurons in this area fire when the bird sings; and, perhaps most telling of all, damaging these cells affects the bird's ability to sing. Remarkably, songbird RA was found to be more similar to human motor area LMC than to motor cortex in the macaque monkey. The Duke group also identified parallels between area X, known to be crucial for song learning in the zebra finch, and a structure in the human brain known as the basal ganglia, which is known to be important for language learning.

The Duke study also found that a molecular similarity between birds and humans is especially pronounced in brain regions that light up in neuroimaging studies in which people produce speech, especially the vowel sounds most analogous to bird song. Interestingly, if you look at molecular similarity to the entire human frontal lobe, all birds were about the same. It's only when you look at genes expressed in brain areas specifically involved in speech production that vocal learners, such as zebra finches and hummingbirds looked more similar to humans than vocal non-learners, such as quail and doves.

The exciting thing about the Duke study is that in spite of hundreds of millions of years of divergent evolution, birds and humans share similar brain circuits for vocal learning marked by similar expression of about 50 genes. Researchers studying the neurobiology of language have long been held back by the lack of animal models. The Duke research raises the possibility of using songbirds as a molecular model for studying speech production. In

this way we may come to understand how the uniquely human trait of language is a new machine made out of old parts.

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