**ScienceWatch – With a Song in My Brain**

Now that I am the grandfather of two one-year-olds I can once again marvel at the transformation of their current babbling into human speech. Scientists believe that infants remember the sounds made by adults and use it as a template for matching their own chatter, eventually producing words, sentences and language. Songbirds are similar to humans in that at a young age both excel at vocal imitation.

In songbirds, which comprise about half of all bird species, learning and production of song is dependent on the "song system", interconnected nuclei of nerve cells that form a complex network in the forebrain. Scientists once believed that bird brains were quite simple as compared to mammals because they do not contain the creases and folds we associate with higher learning. However, newer studies on bird brain neurophysiology have demonstrated the existence of a region of higher learning analogous to the mammalian neocortex and other structures that function just like the mammalian brain. In fact, in 2002 scientists revised the names used for parts of the bird brain to reflect its similarity to that of mammals. These revelations and other studies that have demonstrated the high degree of intelligence exhibited by corvids and parrots make it clear that the old insult "birdbrain" has lost its meaning.

In order to be successful singers young male songbirds must be exposed to the singing of an adult male (a "tutor"), usually their father, after which they progressively modify their own "babbling" to mimic but not exactly match the memory of their tutor's song. For some time now scientists have searched in the song system regions of the brain to discover where the memory of the tutor's song is stored. This has proven difficult because by the time the young male establishes his own song his brain no longer seems to respond to that of the tutor. Now a report in the January 24, 2006 issue of the *Proceedings of the National Academy of Sciences* demonstrates that the memory is retained, but not in the song system. Rather it is stored in an area of the forebrain associated with hearing and not singing.

The study by a team headed by Mimi Phan a postdoctoral associate in psychology at Rutgers University in Piscataway, NJ, used zebra finches (*Taeniopygia gutata*). The researchers developed a "familiarity index" which they used to measure how well juvenile males retained the memory of a tutor's song. Earlier work showed that the "listening" period during which songs are memorized is from 25 – 60 days of age while the "singing" period is from 35 – 90 days. At day 23 juvenile males, already isolated from their fathers at age 10 days, were separated from their mothers and siblings and placed in isolation chambers where they were "tutored" by exposure to recordings of adult male song. The tutoring occurred during the normal period of song development, beginning at day 45 and ending at day 90.

A month after the tutoring ended the team tested for memory retention of the tutor's song. They measured electrical responses in the brain while playing back recordings that included the tutor's song, the bird's own song or a completely new song. A response was

observed in the auditory region of the forebrain known as the caudal medial nidopallium (NCM), but it rapidly disappeared upon repeated playing because of habituation (which we experience when we no longer smell an odor that is apparent upon first entering a room). However, the brain's response to a familiar stimulus doesn't die off as fast as new ones and Phan, et al. could see that the electrical response in the NCM to the tutor's song was longer-lasting than to any of the others.

By comparing the die-off rate for the response to the tutor's song with that for the other songs the researchers developed the familiarity index (FI) for each bird, a measure of how well the tutor's song was remembered. They found a strong correlation between the FI of the tutor's song and how well the birds sang the tutor's song; i.e., the more familiar a bird is with the tutor's song the more its song matches that of the tutor. When the bird's own song or a new song was played back the FI showed no correlation, demonstrating that the FI was indeed a measure of the memory of the tutor's song in the NCM portion of the forebrain.

It's becoming clear that birdsong learning is the closest animal equivalent to the acquisition of human speech. Further studies in songbird model systems like the zebra finch and canary (*Serinus canaria*) will provide a clearer window into the miracle of how we learn to talk.

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