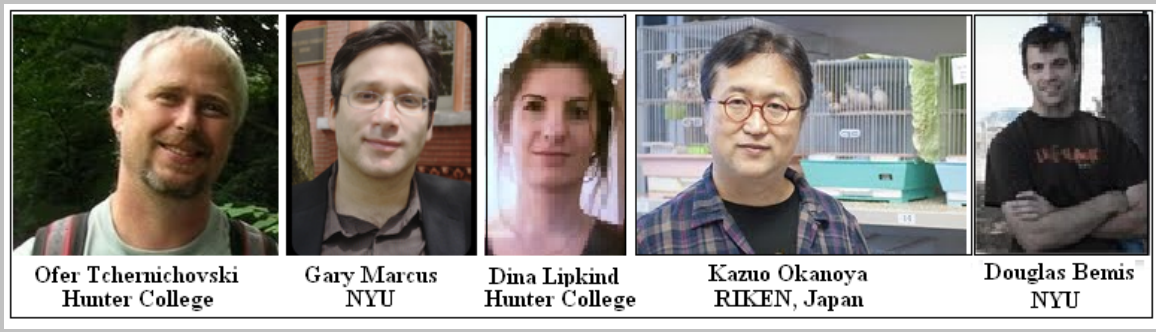
appeared on 5th June 2013

Bricklaying in speech composition

Songbirds, and babies learning to speak, are found to acquire skills in the same way, says S.Ananthanarayanan.

Birdsong has been shown to have structured ordering of different tones, which is akin to the grammatical form of sentences in human language. This is to say that birdcall has syntax, as opposed to the use of animal cries, including birdcall, merely as signals of danger or food, or to keep the flock in communication. Furthermore, birdsong, which is learnt by fledglings from an older bird, has even been shown to have a musical quality, in evoking in other birds a neural response similar to that in humans.

Dina Lipkind, Gary F. Marcus, Douglas K. Bemis, Kazutoshi Sasahara, Nori Jacoby, Miki Takahasi, Kenta Suzuki, Olga Feher, Primoz Ravbar, Kazuo Okanoya and Ofer Tchernichovski, working at institutes in New York, Japan and Israel, have presented in the journal, ***Nature***, a study of the process of songbirds and human infants acquiring the skills of ordering tones in different patterns.

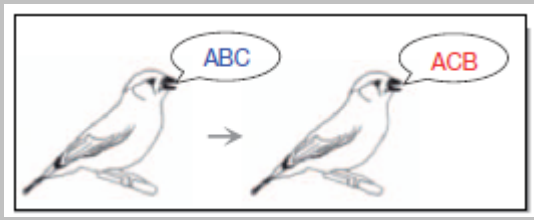


The team traced the course of the learning with help of experiments with the zebra finch and analysis of records the vocal progress of the Bengalese finch and human infants. The ***zebra finch*** is common to central Australia and a loud and boisterous songbird. Its song consists of sequences made up of four different tones, usually starting with a short series of ‘beeps’, followed by other sounds, to create a rhythmic pattern. The ***Bengalese finch*** is a domesticated songbird that has a more complex repertoire than the zebra finch. Apart from a linear sequence of tones, the Bengalese finch creates ‘branches’, or switches from one sequence to another. The human infant is able to switch from a many syllable sequence to others, soon to master the great variety that we find in human speech.

The zebra finch

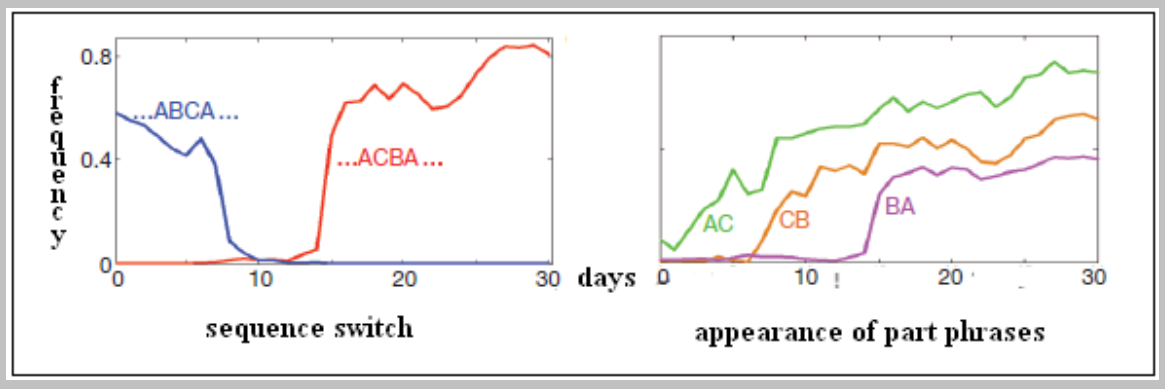
The study of zebra finches was of how they progressed from a sequence of syllables to another where the syllables were swapped, and then where some syllables were inserted into an existing string. Young zebra finches were exposed to a simple song, and the ones which could imitate the song within just over 2 months of hatching were then exposed to a variation of the song. A song represented by the sequence, ‘ABC’, was replaced by the

variation, ‘ACB’. The whole progress, from singing the first sequence, which they had learnt well, to learning the new sequence, and forgetting the first, was examined, using

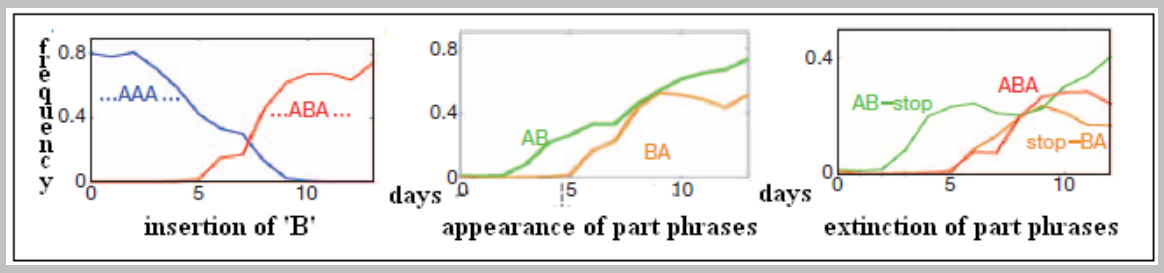


statistical methods to decide when the switch had taken place. It was found that at the end of 17 days (statistically) the new song abruptly appeared. The old song disappeared at once or within a few days.

To identify the intermediate stages of the new song appearing, the team studied when the new part phrases, viz, ‘AC’, ‘CB’ and ‘BA’ appeared and got more frequent, till the whole new song took over, and the old song was forgotten. It was found that the new combinations started appearing in about 10 days, a new combination being repeated thousands of times, while other combinations also began to appear. There were features in this progression, of the newly learnt combinations being attached at either end of old sequences, with faster attachment of subsequent new combinations learnt. The other task that zebra finches were set was to introduce a syllable within a sequence, like inserting ‘B’ into a string of ‘A’s, moving from ‘AAAAAA…’ to ‘ABABA…’ Here, there was a feature of learning of two new sequences, ‘AB’ and ‘BA’, and these new sequences appeared first, before the ‘ABAB..’ pattern took over, and the intermediates were forgotten.



In this case, of learning ‘AB’ and ‘BA’, it would be expected that till ‘BA’ was learnt, ‘AB’ could appear only at the end of a string of As, and then stop, as ‘BA’ had not been learnt. This was found to be the case, the syllable, ‘B’ appearing only at one or the other end of a string of As. But the sequence ‘ABABA..’ appeared abruptly as soon as the complementary sequence was learnt. The abrupt appearance of the new skill, in both cases, indicated the progress of step-wise acquisition followed by expression of the complete skill when the steps had been taken.



In the case of zebra finches, the results were from contrived training of the birds and the results could arise from bias. A control experiment was with Bengalese finches, which grow to be able to rearrange syllables without training. Among Bengalese finches, the group analysed records of mature song, where there were switches between syllables, both ways round – 'A to B' and 'B to A'. One way of explaining how this was done is by assuming that the birds remembered early chance occurrences of the two end phrases, 'AB' or 'BA'. Another way would be to consider that the two transitions were learnt separately, say 'AB' first and 'BA' later.

The group identified cases of birds which did bidirectional transitions and traced their past history of performing the two end combinations ('AB' or 'BA'). It was found to be the case that one combination had been learnt well before the other. In the case of unidirectional transition in the song, viz, 'A to B', again, it was found that the transitions appeared as soon as the components for the transitions were learnt. This discounts the explanation of early chance events and points to skill appearance along with acquisition of components.

The progress of human infants was studied using the records of **CHILDES** – ***Child Language Data Exchange System***, a freely available repository of transcripts, audio and video recordings in over 20 languages. The instance used was recordings of nine US infants, every two weeks, from the age of 9 months to 28 months. Babbling utterances were separated into syllables and occurrences were analysed statistically.

A first finding was that newly acquired syllables tended to be repeated, but the frequency of repetition dropped as the variety of syllables increased with new learning. The expectation, from the lesson learnt from songbirds, was that new syllables should appear at the ends of utterances. This was found to be entirely the case, with new syllable types appearing at the edges of utterances, well above the expectation by chance. And the constant acquisition of new syllable types seemingly affected the increase in thee number of combinations of syllables that were tried out.

The findings, which are common to the three species studied, indicate a gradual, sep-wise progress during early stages of development. The skill learnt is of combination of syllables, with the pruning of transitions that are not required. The study then proposes possible development in the connections between neurons in the brain, which correspond to different syllable combinations. The gradual development in infants could explain why infants, for all their grasp of grammar and syntax, are slow to keep up with vocalizing. But the way songbirds can use simple components to put together complex song patterns mirrors the observation that songbirds and infants use the change from syllable to syllable, in pairs, to transfer from one multi-syllable string to another.