appeared on 30th Nov 2008

The songbird rehearses in its sleep!

The Australian Zebra Finch helps researchers tune into the mechanism of learning, says S.Ananthanarayanan.

The clear harmony and meter of songbird arias have captivated naturalists and musicians alike. On the one hand the natural bases for the diatonic scale (Saragam) and the resonance in tones that lead to harmony. On the other hand the anatomy of the songbirds' voicebox, its range and its power. And then, that a songbird can learn and remember the melody!

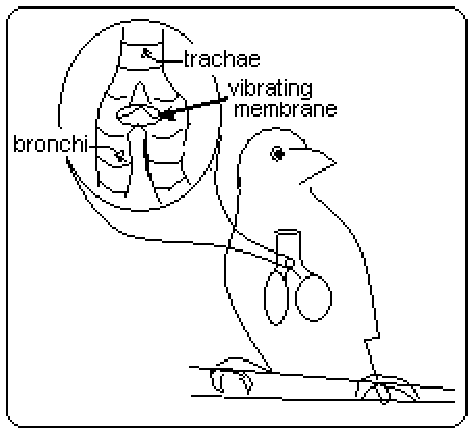
The Zebra Finch

Finches are perching, seed eating birds, usually songbirds, found in many parts of the world. The zebra finch, a variety common in Central Australia, which is gregarious, never seen singly or in pairs, but always in groups of devoted couples, is perhaps the most widely studied of the finches. A great feature of the zebra is its noisy and boisterous singing, in harmony with the group, sometimes of hundreds of birds, and virtuoso individually.

How the zebra finch is able to belt out all those tones, often two tones at a time, and with the power and volume of an opera singer has been a subject of special study. The voice box has much in common with the human apparatus and is hence of particular interest. The journal, ***Nature*** this week reports the studies of Sylvan Shank and Daniel Margoliash of University of Chicago, into how the zebra finch masters the tone and melody that it learns from its 'song tutor', a male finch, usually the father.

Research into voicebox

During the last few years, scientists have managed to slide optic fibre cameras down the zebra finches' throats without disturbing the birdsong and take pictures of what moves when the birds hit high or low notes. And only recently, scientists have been able to access the birds' singing organ, the ***syrinx***, that plays the role of the human larynx. In birds, this organ is not in the neck, where it can be reached, but is buried deep within the bronchi, among muscles near the heart. But now that scientists are able to see deep within, they have discovered the remarkable feature that the birds have two soundboxes –

	The first can sing one tone while the other produces another tone, a songbird can do a duet all by itself! And the most interesting thing is that the voiceboxes use a membrane vibrator with structure similar to the human equivalent. Mimicking human speech through technology has not made significant progress. This may be at least in part because we still do not understand how the human apparatus works. Research into the zebra finch's voicebox could thus have more than academic value

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Birdsong and the brain

Another take on the finch and birdsong is how does the finch acquire its repertoire, how does it perfect its technique and how does it store what it has learnt. Understanding this process is clearly of great practical value, even more than just how does the finch have such a great voice!

The typical call of the zebra is a 'beep', or an 'oye', sounded a lot like a toy trumpet or the sound a push-button telephone makes when we press the keys. But with just a few variations of beeps, the zebra composes complex patterns, each one unique, though groups of birds often share similarities.

The male finch is the main songster, because of oestrogen present in the development of the male embryo, which promotes a network of nerves cells that aid song learning. Finches usually start with disjointed beeps, but with practice and much imitation of male companions, largely the father finch, which is responsible for feeding the fledglings, the young finch consolidates a range of patterns. But the important thing is that the finch actually learns, from his own experiments or the templates of others, and this behaviour has been of interest, to illuminate the process of learning and skill acquisition.

Sleep and learning

That sleep helps consolidate learning has generally been observed and there is evidence that it is during sleep that patterns of neurons, or nerve cells in the brain, form, in a way that corresponds to events just experienced and changes that are later seen in behavior. In finches, the day-night changes in singing behavour have been seen to be dependant on sleeping patterns.

Shank and Margoliash of the University of Chicago looked ‘under the hood’ with surgically implanted probes to study neuronal activity in zebra finch forebrains under different conditions. In sleeping adult birds, it was known that there is spontaneous electrical activity in this region of the brain, corresponding to the preceding (ie day-time) singing and listening activity. Shank and Margoliash arranged for a ‘tutor’ song to be played back to the finch during the day, and found that there was marked activity in the brain when the finch next went to sleep. And if there had been activity in the brain during sleep, there were changes in the birdsong when the bird awoke refreshed!

Interruption of the playback experience reduced the level of neuron activity and also the learning that took place. This suggests that the interruption affected the tutor-song-specific remodeling of the neuronal network. The Chicago researchers propose that the ‘bursting’ activity during sleep that follows exposure to training inputs promotes changes in the ‘***pre-motor***’ region of the brain, which are the physical bases of ‘learning’, in the case of songbirds.

How far this helps pin down the mechanism of learning and memory, in animals generally, remains to be seen.