Canaries change their tune

Maths says bird song is as simple as muscle and breath control.

2 November 2001

PHILIP BALL

Canaries owe their complex songs to good voice control, according to a new mathematical model. By manipulating the air pressure and muscles in their vocal organ, the syrinx, birds can produce a huge repertoire of sound, Tim Gardner of Rockefeller University in New York and colleagues calculate[1].

Male canaries wow females with their vocals. © Dr. Hans Classen

audio

The team hopes that uncovering the mechanics of sound generation in birdsong might help to explain how the animals' singing is linked to brain activity, and thus how birds learn their songs. Male canaries and other birds use song as a mating call - a singer's prowess may advertise his fitness and wow females.

The syrinx forces air through the bird's two bronchial passages at the point where they connect to its windpipe. At these two junctions are flaps of tissue, called labia, on the inner and outer sides of the passages. These act like the reed of a clarinet, vibrating the air that passes them. Muscles in the syrinx alter the stiffness and the gap between the labia, changing the resonance of the passing air.

Gardner's group proposes that birds change their tune by adjusting just two factors: the air pressure in the syrinx and the stiffness of the labia. In other words, they blow harder and tighten their throat. We whistle, in contrast, by subtly changing the shape of our mouth cavity to alter pitch.

In the researchers' model of the syrinx, the shapes of the passages and labia are simplified. When opening, the labia have sloping, roughly trapezium-shaped profiles; on closing, their profiles are flatter. This simple shape change, alongside

relatedstories
- **Birds fly best on a full tank** *18 October 2001*
- **Flycatchers caught on the hop** *17 May 2001*
- **Wide repertoire wins mates** *4 December 2000*

morenews
- **Bacteria make bandage glow** *7 November 2001*
- **Drop in found out** *7 November 2001*
- **Genes show seasonal trends** *6 November 2001*
- **Wall-to-wall power** *6 November 2001*

variations in the pressure of air coming from the lungs and in labial stiffness, produces a striking result.

pressure and stiffness tune a bird's song

Below a threshold pressure, air simply passes the labia without making them oscillate. Above the threshold, oscillations create sound waves, the harmonic richness of which increases as the pressure increases. This is a simple way to control the timbre of a song - rather like the difference between playing on a recorder and on a trumpet.

But birdsong is not a sequence of distinct notes. It is divided into separate 'syllables', each one a tweeting sound whose pitch is varied smoothly. The model syrinx mimics these rather complex frequency changes of single syllables when pressure and labial stiffness rise and fall cyclically, Gardner and his colleagues show.

Pressure and stiffness can thus be considered as the two 'dials' that tune a bird's song. Simply by altering these variables repetitively and independently, the researchers created an artificial song, complete with subtle changes in harmonic content, that closely resembled real canary song.

References

1. Gardner, T., Cecchi, G., Magnasco, M., Laje, R. & Mindlin, G. B. Simple motor gestures for birdsongs. ***Physical Review Letters***, **87,** 208101 (2001).