NEURONAL CIRCUITS

Cooling song production

Complex motor behaviours require the carefully timed coordination of different muscle groups, yet how this timing is controlled is not well understood. In their new paper,

Long and Fee describe an ingenious strategy for investigating these processes and shed light on how the timing of song production is controlled in the forebrain of

the zebra finch.

The adult zebra finch song has a hierarchical structure: it consists of repeated short motifs, each of which is comprised of a series of

syllables that are themselves made up of subsyllabic components. Previous work had suggested that different regions of the forebrain — specifically the nucleus HVC (high vocal centre) and the target of its projection neurons, the nucleus RA (robust nucleus of the arcopallium), or even respiratory centres — might control the timing of different levels of song structure; however, this has been difficult to test directly with existing techniques.

Fee and Long exploited the relationship between brain temperature and the speed of brain processing by using a thermoelectric cooling device to temporarily slow activity in specific regions of the forebrain without drastically perturbing function. They found that cooling the HVC bilaterally by up to 6 °C dramatically affected all levels of song timing: both syllable and motif onset were slowed down and the durations of the subsyllabic structures, syllables and motifs were extended. By contrast, cooling the RA had no effect on song timing.

A longstanding question has been how the HVC nuclei in the two hemispheres of the forebrain coordinate their activity. The authors showed that although cooling only one HVC nucleus slowed song production, it did not produce the song degradation that would be expected if the two hemispheres were synchronized only at the beginning of each motif. This confirms earlier hints that the two sides of the brain are re-synchronized multiple times throughout song production.

These findings suggest that the HVC controls song timing on multiple timescales, shedding light on the organization of the circuits that control song production. Furthermore, the cooling technique devised for this study could be applied more widely to the investigation of the timing of complex behaviours.

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ORIGINAL RESEARCH PAPER Long, M. A. & Fee, M. S. Using temperature to analyse temporal dynamics in the songbird motor pathway. *Nature* **456**, 189–194 (2008)

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