1 Temperature induced syllable breaking unveils nonlinearly interacting timescales in birdsong motor pathway.

Goldin MA, Alonso LM, Alliende JA, Goller F, Mindlin GB.

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Controversial, Interesting Hypothesis, New Finding

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The canary's song can be divided into a sequence of syllables, each of which has different frequency characteristics. Here, the authors experimentally test a hypothesis first proposed in {1}, which explains this pattern in terms of two oscillators. They propose that HVC oscillates at syllabic rate, driving another downstream oscillator in RA, which has a particular natural resonant frequency. (HVC and RA are nuclei in the pallium, the avian correlate of mammalian cortex.) By changing the frequency and amplitude of the HVC oscillation, the output of RA changes nonlinearly, but in a predictable way. In this way, drastically different types of syllables can be created by simple changes in HVC.

This model is in contrast with another prominent theory of birdsong generation {2}. According to this model (and data from zebra finch), HVC contains cells specialized for individual times in the song. These cells each drive RA in a feed-forward manner to produce the particular sound corresponding to that point in the song. The HVC-as-timer hypothesis had been tested previously by cooling HVC during song and observing that all timescales of the song were lengthened {3}. However, that paper only looked at temperature changes for which the song structure remained the same. The current paper uses the same cooling of HVC technique, but extends the analysis to temperature ranges after which the song structure "breaks". As predicted by the authors' HVC-as-oscillatory-forcing hypothesis, such cooling does not always lead to a lengthening of syllables. Rather, some syllables lengthen, some shorten, and some change to a completely different shape. Specific data patterns were reproduced by their model by simply changing the frequency of the forcing oscillation while holding other parameters constant.

So far all of the authors' experimental work has been on the behavioral output of the system (air sac pressure), so the localization of the oscillators involved is speculative at this point. Neural recordings must be done in order to falsify or establish the validity of this hypothesis.

When taken together with their previous experimental and modeling evidence for their HVC-as-oscillatory-forcing hypothesis {1,4}, this work suggests that the field take a serious look at the idea that the motor control in birdsong is not strictly top-down, but depends on nonlinear interactions of multiple neural oscillators. A related dynamical systems view of motor control has been put forward in monkey motor/decision research {5}.

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