WHAT'S THE BIOBUZZ?

A journal for students by students

How similar are birdsong and human speech?

Key Terms

Term 1: Syllable
For birdsong, this is a burst of sound that is followed by a brief silent period. For human speech, this is the basic unit in the organization of sounds.

Term 2: Motif/Phrase
A short sequence of birdsong syllables.

Term 3: Tutor
An adult songbird that a juvenile would learn how to sing from. A tutor is usually the juvenile's father.

Term 4: Spectrogram
A visual representation of sound in the form of a graph (see figure 2).

Term 5: Frequency
The number of times an event occurs per unit of time. Sound frequency is what mainly determines pitch.

Term 6: Physiological
Relating to the way a living organism or body part functions.

Figure 1: A zebra finch, a species of songbird known to be able to imitate vocals. This species is used in these studies.

ABSTRACT

How birdsong and human speech are developed actually have a lot in common. Both birdsong and speech have complex structures and can be learned from adults at a young age. Because of this, these two vocals are often compared.

Throughout the years, scientists have been studying birdsong structure and vocal development and connecting their findings to the development of human speech. One recent insight has to do with how different **syllables** come to be.

As shown in **Figures 3 and 4**, as a songbird develops, its initial formless singing evolves into a song with clearly defined sounds. And having an adult **tutor** song to help guide its learning strongly influences how the juvenile's final birdsong turns out. Likewise, with humans, a child's recognizable words emerge from initially highly unstructured early vocals, and hearing words from the people around them helps them better learn the language.

A **physiological** reason is also behind these vocal progressions, and combining behavioral and physiological studies on vocalization, along with further comparative analysis may ultimately lead to a greater understanding of human speech.

WHY STUDY BIRDSONG?

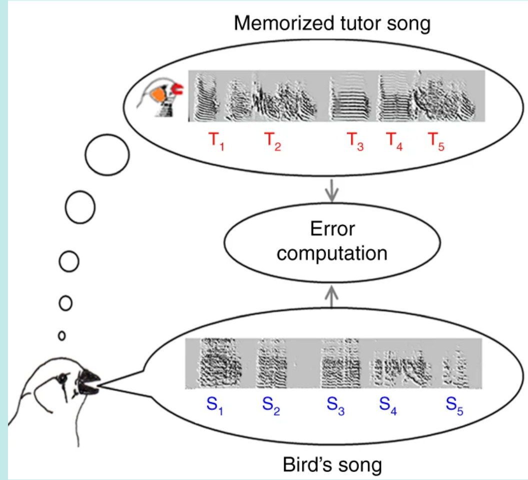
Birdsong and human speech actually have things in common. Both birdsong and human speech are highly structured, and they can be learned from adults at a young age. Because of this, these two vocals can be compared.

With birdsong, sound units called **syllables** can be grouped into sequences called **motifs** or phrases. Multiple motifs can then be grouped to form a whole song. Likewise, with human speech, multiple syllables can come together to form words, which can in turn be combined to form sentences.

Now, just like we have many different words, various versions of birdsongs exist, each with their own distinct sounds. Scientists are studying how these birdsong sound structures come to be different, and with their findings they can, in turn, better understand the vocal development of human speech. Here is one recent insight.

METHODS

First, scientists measured and analyzed the song of a songbird as a juvenile (40 days old) and as an adult (90 days old). Data is represented as two sets of graphs, one of which is a **spectrogram**. They also introduced a young pupil bird to the song of an adult **tutor** and then measured the song of this pupil at several points after first exposure to the tutor song.



How would one test a songbird's vocal learning strategy?

FIGURE 2: There are various ways one can test a songbird's vocal development and learning strategy. One way is to introduce a young bird to the singing of an adult **tutor**, which is usually its father. The juvenile tries to commit this song to memory and then sings a song of its own. The sounds of this birdsong as well as the tutor song can be measured and represented as so-called **spectrograms**, as shown in the grey rectangles above.

A spectrogram shows how different sound **frequencies** (y-axis) change over time (x-axis). As for reading one, think of it as reading sheet music: songs read from left to right, and higher-pitched notes are near the top of the graph while lower-pitched ones are near the bottom. Additionally, the horizontal length of each black area in the graph shows how long each sound lasts, and shape indicates sound quality.

RESULTS

Both sets of data seen here show how a juvenile songbird's formless **syllables** evolve into clearly distinct syllable types as the bird develops.

As seen from **Figure 3A**, the song of an adult male bird is highly structured. Here, it consists of two motifs, each with three syllables. These syllable types are discrete, as shown by their distinct shapes on the left and defined clusters on the right. In contrast, as seen in **Figure 3B**, the song of a juvenile is unstructured. Syllables are highly variable and lack real definition.

Figure 4 gives a closer look at how a young bird's syllables become more discrete over time. After only a few days of being exposed to the tutor song, the young bird's song is still lacking in shape and structure. But after a while, the syllables become more defined in terms of sound, and more and more similar to the tutor song.

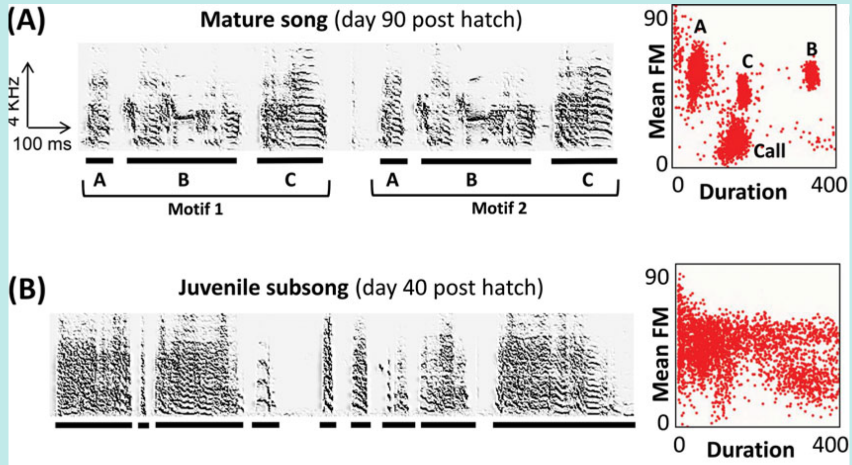


FIGURE 3: Comparing the sounds of a song of A) an adult male zebra finch (90 days old) and B) that same bird but when it was younger (40 days old). On the left are spectrograms, and black lines indicate syllables. Lettered syllables, as in (A), indicate distinct syllable types. On the right are further visualizations of sound structure. With the adult, there are defined clusters of red dots, indicating discrete syllable types. In (B), dots are randomly scattered throughout, indicating no real contrast in syllables.

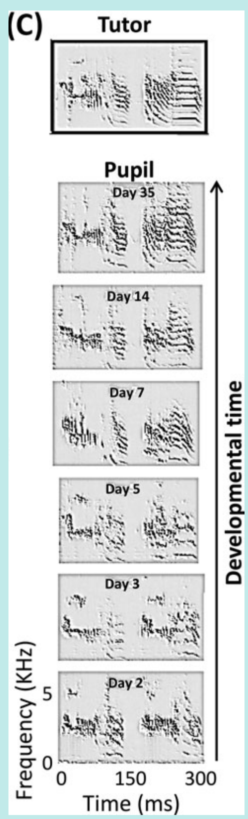


FIGURE 4: More exploration of birdsong vocal development. Depicted here are spectrograms of the tutor song and a young pupil's song at several stages of its life. Days indicate the number of days after the pupil's first exposure to the tutor song. Results show how the pupil's initially random sounds eventually develop into two discrete syllables that are similar to the tutor song.

DISCUSSION / CONCLUSION / SO WHAT?

- In a songbird's vocal development, highly structured birdsong, which consists of discrete syllable types, emerges from initially unstructured and variable singing. Learning the song from an adult tutor would strongly influence how the juvenile's final song is structured.

- Likewise, in humans, the early words of young ones arise from highly unstructured early vocals. Initial random sounds first develop into consonant-like and vowel-like sounds and then evolve into distinct consonant and vowel syllables. With the help of an adult "tutor" to learn from, this child can join syllables together to form words that resemble our language.

- For both songbirds and humans, this vocal progression can be tied to the increased **physiological** ability to control breathing and vocalizing upon growing up.

- Combining behavioral and physiological studies on vocalization along with further songbird-human comparative analysis may inspire future research in these fields and lead to a greater overall understanding of human speech.

- Something else to think about: So now, so far, we learned how syllables come to form, and how a motif is a sequence of multiple syllables. What about how these songbirds arrange these syllables in the sequence? (You can read more about this in the first paper referenced below!)

Adapted by Jessica Desamero
Mainly from *The Development of Structuralized Vocalization in Songbirds and Humans: A Comparative Analysis* by Dina Lipkind *et al.*, Topics in Cognitive Science, 2019
& Figure 2 is from *Songbirds work around computational complexity by learning song vocabulary independently of sequence* by Dina Lipkind *et al.*, nature communications, 2017