

## **The synaptic architecture of song learning**

When young infants learn to distinguish the sounds of their mother tongue, they gradually become insensitive to sound differences in foreign languages. But what happens in their brains during the perception of speech is poorly understood. Nothing is known about the influence of speech perception on the development of synaptic connections through which neurons communicate with one another.

Of particular interest are excitatory and inhibitory synapses and their neurotransmitters. The latter are associated with the pathophysiology and the treatment of many severe mood disorders, including depression. The synaptic balance between excitation and inhibition is considered an important principle for normal brain function.

We study the organization of synapses during developmental learning in the songbird, the Zebra Finch. Like humans, zebra finches learn their vocalizations from an adult tutor during a critical phase very early in life.

In our publication <https://elifesciences.org/articles/37571>, we report that the first perception of song in zebra finches is associated with a rapid formation of inhibitory synapses and a rapid removal of excitatory synapses in the brain region that later in life produces an imitation of the heard song. We analyzed electron microscopic images of young zebra finches who either never or only for one day in their lives heard birdsong. We find a significant difference between the number of synapses in these two groups of birds. The initial hearing of birdsong leads to a dramatic increase in the relative number of inhibitory synapses by over 40% and within only 24 hours.

Songbird research is most impactful where medical insights are challenging, such as in small children. A better understanding of the structural dynamics of synapses during critical learning provides clues to the neurobiological principles of memory formation and to the foundations of perceptual development. Insights on the formation and elimination of synapses can also lead to improved therapies of mental disorders. For example, based on our findings, the time of perceptual exposure and medication intake in exposure therapies could be better adapted to natural requirements.