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Exceptional hearing ability in a hummingbird

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ABSTRACT

The Ecuadorian Hillstar sings with the highest pitch among birds. We showed that this hummingbird can hear these vocalizations and use them to court females, becoming the first bird species that communicates using high-pitch sounds.

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Many birds communicate using songs. Among them, the Ecuadorian Hillstar hummingbird produces a song with the highest pitch.

Our previous research suggests that these hummingbirds produce high-pitch sounds to stand out from ambient noise. For vocal communication to be effective, the listener needs to hear the sounds that another individual is producing; and birds hear best at the same pitch at which they sing. Thus, if the Ecuadorian Hillstar produces high-pitch songs to communicate, we would expect that this hummingbird can detect similarly high sounds coming from other hummingbirds of the same species.

But how do we ask a hummingbird which sounds it can hear? We designed two experiments to test the hearing ability of this remarkable bird. First, we played back a high-pitch song to the hummingbirds in the field. Just like humans, when other animals hear a sound that calls their attention, they look around searching for the source of sound. Moreover, birds react distinctly when they hear the song of a different male inside their territory. They often respond with aggressive calls and displays towards the speaker, which they perceive as an intruder. We found that Ecuadorian Hillstar hummingbirds followed these patterns by tilting their heads, extending their necks and adjusting the position of their body towards the source of the song. We also played environmental noise at a lower pitch, but

hummingbirds did not respond to these sounds as they did to the high-pitch song.

We also studied the responses to high-pitch songs in the hummingbird brain. Normally, when the brain detects a relevant cue in the environment, a song of the same species in this case, neurons in several regions of the brain activate to process the information. This activation triggers a process known as 'gene expression', where information stored in the genes is used to guide the synthesis of functional products, such as proteins. In the past, scientists have seen that a gene called 'zenk' is a good indicator that a neuron has been activated. So, we searched for this gene in neurons in the auditory regions of the hummingbird brain, and we found that the auditory regions in hummingbirds exposed to the high-pitch song were more active than the same ones in birds not exposed to any sound. Based on the behavior and brain responses, we concluded that the Ecuadorian Hillstar can hear its high-pitch song.

But what are the functions of these sounds? Previously, we observed that the Ecuadorian Hillstar uses these songs to defend its territories. So that, a male controlling a patch of flowers lets other males nearby know that a territory is already taken. Eventually, we also found that Ecuadorian Hillstar males sing the high-pitch song to females during courtship. Courtship displays are common among animals and consist of a series of behaviors aimed at showing off the attributes and ornaments of males. Females evaluate these displays and choose their favorite male to mate. During courtship, Ecuadorian Hillstar males hover in front of females displaying their feathers. At the same time, they sing their high-pitch song, which makes the feathers of the head vibrate, enhancing their iridescent purple color.

While some owls have specialized ears that allow them to detect high-pitch sounds for hunting, they do not use this ability to communicate with other owls. The Ecuadorian Hillstar is the only bird known, to this date, for communicating using high-pitch songs. It is likely, though, that other species of hummingbirds can hear and use them for communication too. Understanding how these hummingbirds have evolved to communicate using high-pitch songs will teach us more about the ways in which the brain adapts to sense information in the environment and facilitate communication and social interactions in nature.