Tuning in to a new language on the fly: Effects of context and seasonality on songbird brain

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Research conducted at Rutgers University has shown that exposure to a changed acoustic and social environment can rewire the way the brain processes sounds. Beginning in the cochlea of the inner ear, nerve cells of the auditory system parse incoming sounds into their different components. Study of the responses of individual brain cells has shown that they respond best to a particular frequency (pitch) of sound, less well to nearby frequencies, and poorly to distant sound frequencies. The range of effective frequencies can be measured as the "tuning width." Cells with similar tuning are found together, producing an orderly map of all the possible frequencies spread out across the auditory part of the brain.

In a new study, published August 6 in the online, open-access journal *PLoS ONE,* these tuning properties were used to study the way experience can change the brain in two species of songbirds. Songbirds provide the best-developed animal system for studying vocal learning because juvenile birds learn to sing by hearing and imitating adults, much as human infants do. The songbird brain contains an area similar to the mammalian auditory cortex (the NCM) that is specialized to discriminate and remember the songs of other birds of the same species.

In this study, adult zebra finches (which normally live in a single-species colony) were moved to a canary colony, and adult canaries were moved to a zebra finch colony. These birds experienced a novel environment because canaries and zebra finches produce learned species-typical vocalizations that differ in their acoustic components. Other birds of each species remained in their home colony and still others were placed in individual isolation.

After nine days of altered experience, the tuning width was assessed in the brains of these animals and was found to be significantly different from birds that remained at home. In birds of both species that experienced life in a foreign colony, the tuning became narrower (i.e. more selective). In canaries, which can learn new song elements in adulthood, these effects were also influenced by season, and may reflect the role of vocal imitation in the seasonal breeding behavior of this species. Isolation had the opposite effect: the tuning became wider (i.e. less selective).

In other words, when a bird is exposed to a new acoustic and social environment, basic auditory properties in its brain change to become more finely tuned. In human terms, a possible analogy for this experiment is when a person travels to a foreign country where an unfamiliar language is spoken. The individual has to pay close attention and gradually begins to make out the words in the speech stream (and perhaps to recognize a few from the phrase book). This process of "tuning in" to the new sound and social environment may involve increased sensitivity to fine acoustic details and may produce measurable tuning changes such as those observed at the neural level in these songbirds.

In contrast, the songbirds' tuning coarsened in the impoverished, monotonous environment provided by being housed in isolation.

The researchers suggest that these songbird results provide a useful experimental model of sensory plasticity accessibility, which is worthy of further study. Consistent with observations in other sensory systems, the tuning map in the brain is not rigid, but adjusts dynamically to current experience.

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