Abstractions

FIRST AUTHOR

Among the brain's many mysterious goings on are theta oscillations. This term describes a brain rhythm observed in the hippocampus — the area responsible for long-term memory and spatial navigation — in many mammals, including rodents and humans. Although the oscillations' function is not fully understood, they are thought to be the 'clock' that controls the timing of hippocampal activity. The prevailing view is that theta oscillations occur synchronously across the hippocampus. But on page 534, Evgueniy Lubenov and Athanassios Siapas of the California Institute of Technology in Pasadena challenge that assumption, demonstrating that theta oscillations do not occur in synchrony, and instead travel across the hippocampus. Lubenov explains why these experiments required considerable patience.

Why did you question the prevailing view?

While recording electrical activity in different regions of the rat hippocampus, we saw differences between electrodes in the phase and amplitude of theta oscillations. Such variations would usually be attributed to the fact that the electrodes were implanted at different depths, because theta phase and amplitude are known to vary according to depth in the hippocampal layers. We wondered whether phase might also depend on other factors, for example, anatomical location across the hippocampus.

How did you tackle the problem?

We started with a series of experiments involving long vertical probes with multiple recording sites, which allowed us to map the depth-dependence of theta oscillations with high resolution. We found a 400-micrometre-thick layer of the hippocampus where the phase of theta oscillations is insensitive to depth. Using custom arrays, we then positioned grids of 28 electrodes in this target region and compared the phases of theta oscillations recorded at different anatomical locations across the hippocampus in freely behaving rats.

What did you find?

That theta oscillations propagate in a consistent direction, and so travel through a series of 'time zones' along the length of the hippocampal axis. We plan to study the mechanisms responsible for these waves. This will help us to reveal how information flows and is processed in the hippocampus.

Was it hard to make these measurements?

Making simultaneous recordings over roughly one-third of the hippocampus in freely behaving animals is not easy. It can take several weeks to gradually position this many electrodes to their targets. ■

MAKING THE PAPER

Olga Fehér

Songbirds' melodies have roots in both genes and environment.

Just as humans teach their children to speak, juvenile birds learn to sing from their parents. In zebra finches, songs are the preserve of the male, and are passed from father to son. When young males are deprived of such training, their song is a poor rendition of that typical of the species. So what does that mean for generations to come if these untrained singers take on the role of tutor? For her doctoral dissertation at the City University of New York, Olga Fehér set out to find an answer.

Fehér's experiment involved having an 'isolate' male zebra finch — one reared in the absence of birdsong — raise a brood. One of the finch's progeny went on to become the main breeding male for the entire colony. Over three to four generations, each subsequent set of offspring came progressively closer to singing the species-specific song. From this finding, Fehér concludes that a culturally transmitted behaviour such as birdsong is determined in part by genetics and in part by environment.

The experiment's success relied on access to the latest sound-analysis technology. Previous studies of birdsong from untrained versus trained birds were able to merely eyeball the differences in 'syllables' as represented on a sonogram. "But that really doesn't cut it when you want to quantify subtle changes in birds' songs," Fehér says.

To obtain more precise measurements, Fehér took advantage of a long-standing collaboration between her PhD adviser, Ofer Tchernichovski, and Partha Mitra, a theoretical physicist at Cold Spring Harbor Laboratory in New York. Mitra helped Tchernichovski to develop sound-analysis software for studying birdsong. It took into account ten different variables of sound, including frequency variation and amplitude. As a result, Fehér was able to compare different birds' songs using objective measurements (see page 564).

Other experimental methods were less sophisticated, albeit equally effective. Fehér needed a low-budget, sound-attenuating chamber in which to keep her song-naive bird colony. After searching the streets of New York City for discarded refrigerators, she found one within her building. She laid the refrigerator on its side and had it equipped with ventilation, lighting and microphones, as well as perches, swings, nest boxes and food.

Mating the isolate male was not easy. At first, none of three females placed in the cage showed any interest in him, possibly because they were accustomed to normal zebra-finch song and were not attracted to his unusual vocalizations. "We don't know much about their preferences," Fehér says of her female finches, "but one of them eventually took to the male".

After that, Fehér was able to let the colony evolve naturally. "Who learned from whom wasn't really controlled. What fascinated me was that, looking at the sound, it seemed as if the male offspring were imitating their father. But they obviously also had input from their siblings, especially those from previous clutches." Such influences, Fehér believes, are what led to the gradual progression towards wild-type song.

Although the nature-versus-nurture debate was not the inspiration for the study, Fehér says, "it's an interesting example of this interaction, because it shows how strong the input is from the nature part. But it doesn't work without the nurture." ■

FROM THE BLOGOSPHERE

Where science is concerned, the media is often guilty of presenting only one side of a story. On the Climate Feedback blog, *Nature Reports Climate Change* editor Olive Heffernan addresses complaints that only 'doom and gloom' stories were reported from the recent International Scientific Congress on Climate Change in Copenhagen (http://tinyurl.com/r5c9bo). She gives readers a glimpse of how difficult it is for a reporter to glean the most newsworthy information from a large scientific conference.

Many news stories that emerged from the congress focused on estimates of sea-level rise — the only topic presented in a press conference. Some might argue that "reporters were simply picking the low-hanging fruit rather than seeking out diverse news stories amid the numerous (57) sessions," writes Heffernan. "But if you have to file on deadline, then getting a heads-up on new exciting research with sources in attendance isn't a bad strategy." She adds that the social-science presentations on avoiding climate catastrophes are more subtle stories that require long-term research and reporting beyond breaking news. ■

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