Brain Center Linked to Perfect Pitch

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based on microsatellite repeats—easily recognized patterns of repeated nucleotides—make particularly good bookmarks. And because baboon feces contain a morass of DNA—some from the animal, some from partly eaten plants, some from bacteria—researchers felt that without the proper primers, extracting the right DNA was a hopeless task.

But when human microsatellite primers became commercially available in the last couple of years, Constable decided to tackle the problem for her doctoral thesis. Although not identical to baboon DNA, many human microsatellite sequences are similar to those in the other great apes and very different from other animals. Still, the yearlong project was "so difficult, it almost drove me crazy," she says.

She began by working with dung collected by Packer and his field assistants from 40 olive baboons at Jane Goodall's Gombe Stream Primate Research Center in Tanzania. The first step was to rid the feces of plant compounds that can inhibit PCR. Constable then extracted DNA and used it in a PCR reaction with the human primers. After months of juggling variables such as reaction temperature, Constable eventually was able to amplify DNA from 39 out of 40 baboons.

She then sequenced one locus, D4S243. As a check on the accuracy of the sampled DNA, she compared the DNA from the feces to the same DNA locus from the hair of these baboons. (The hair was collected when the animals were sick and were tranquilized and given antibiotics.) The hair and dung sequences matched, indicating she had not mistakenly amplified a contaminant. The sequenced baboon DNA also aligned with the human sequence for that locus (although there were some differences among the nucleotides), indicating that Constable's primers had bracketed the right target.

Now that Constable has what Packer calls "the smoking gun," she will attempt, by comparing sequences from the male Gombe baboons, to determine which ones have actually fathered offspring and to address the larger issue of male mating strategies. Like many primates, male baboons employ a variety of techniques—from dominating a female to building upon an initial friendship—but without the paternity data, researchers cannot say which of these methods actually results in offspring.

Other researchers want to tackle questions about genetic variability and to use the technique to study other species. "Primatologists are usually trying to dodge this stuff," Packer says, noting that apes have a habit of defecating from tree limbs. "Now we'll be out there with our baseball mitts."

–Virginia Morell

NEUROBIOLOGY

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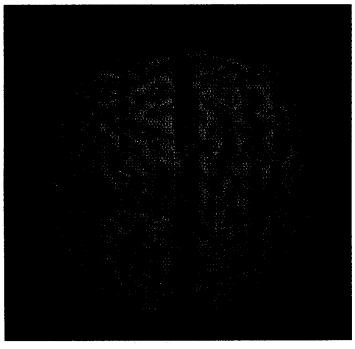
For as long as remarkable mental capacities have been recognized, scientists have strived to find their physical embodiment—usually to no avail. But a research team from Düsseldorf, Germany, may have located the physical basis of one exceptional form of mental performance: perfect pitch—the ability to identify any musical note without comparison to a reference note, a talent displayed by Mozart, among others.

On page 699, a team led by neurologists Gottfried Schlaug and Helmuth Steinmetz of Düsseldorf's Heinrich Heine University report that the planum temporale, a region of the brain cortex that processes sound signals, is far larger on the left side than on the right in professional musicians—and especially in those who have perfect pitch. "It's quite remarkable that one can find a morphology in the brain that is related to perfect pitch," says Robert Zatorre, a cognitive neuroscientist at the Montreal Neurological Institute in Canada.



GOTTFRIED SCHLAUG

Asymmetric. The planum temporale *(red)* is larger on the left side of the brain in musicians with perfect pitch.

The new findings were expected in one respect: They lend additional support to the theory that highly specialized human mental functions occur predominantly on one or the other side of the brain. But in another, they're unexpected, as previous studies, including some of Zatorre's own, had suggested that music is predominantly processed on the brain's right side, not its left.

Schlaug and his colleagues decided to examine the relative sizes of the left and right planum temporale in musicians' brains because previous work had shown that a leftward asymmetry there is associated with mental functions unique to humans, such as language. The neurological basis of music-making is likely to be there, too, says Steinmetz, as music may be "an even higher function" than language. Schlaug, who is now at Boston's Beth Israel Hospital, says the team's interest in the planum temporale was reinforced by a 1950s study of a German musician who suffered melody-deafness after a stroke, apparently as a result of damage to his planum temporale.

The bilateral comparisons were carried out by means of magnetic resonance imaging, which allowed the researchers to measure the volume of specific brain structures. They compared the images of the brains of 30 professional musicians—11 with perfect pitch, 19 without—with those of 30 sex- and age-matched nonmusicians. The left planum temporale was larger than the right in both musicians and nonmusicians. But the size disparity was twice as great for the musicians, a difference almost entirely due to the presence in the group of musicians with perfect pitch.

Schlaug doesn't know, he says, whether the asymmetry and the associated musical talent are inborn traits or whether they can be acquired through training, although results from his and other groups suggest training would have to begin early to be of any use. Studies have shown that 95% of musicians with perfect pitch start their training before age 7, and the Schlaug team found that musicians who began at an older age and who didn't have perfect pitch showed no more asymmetry than nonmusicians.

Although other findings, including some reported just last year by Zatorre and his colleagues in the *Journal of Neuroscience*, suggest that listening to an unknown melody activates parts of the right brain, not the left, the two sets of results may not be as contradictory as they initially appear. "We may well be looking at two aspects of the same phenomenon," says Zatorre. That is, he says, some components of music may be processed in the right brain cortex and others in the left.

If various musical functions are divided in this way, neurologist Albert Galaburda of Beth Israel Hospital suggests that the pitch processing center is on the left because that function requires both verbal and musical skills. He points out that the left planum temporale also includes Wernicke's area, the seat of language comprehension. "My guess is that [the extreme leftward bias in musicians with perfect pitch] has to do with the ability to make the verbal association and say, 'This is a middle C; this is an E flat,' " he says.

The larger question of why brain processing of music is lopsided even in the absence of perfect pitch remains unanswered, however, although one theory holds that processing of complex information may be more efficient if signals don't have to be transferred from one side of the brain to the other. But what is clear, says Schlaug (who doesn't have perfect pitch but was an acclaimed organist before he entered medical school), is that for a musician "perfect pitch is a gift, a real talent."

–Rachel Nowak