U.S. NEWS

How Scents of Smell Are Rooted in Math

Crushed coriander seeds burst with a lemony aroma. Golden turmeric smells like corn cakes. Cardamom gives off a hint of bitterness. And pulverized cumin seeds smell like moist, peppery earth. Combine them, and you have the fragrant beginnings of curry.

But how does a nose, bombarded with odors that arrive in different amounts and combinations, consistently identify each aroma?

THE NUMBERS
JO CRAVEN MCGINTY

It turns out that it is simpler than many other neurobiological processes, and can essentially be broken down into a predictable mathematical pattern.

Odors arrive in small packets—tiny bouquets of molecules—that are inhaled. Receptor cells inside the nose respond by producing a series of electrical spikes, which are communicated to the olfactory bulb in the brain, where the smell is decoded.

"It's like Morse code," said Upinder Bhalla, a professor of neurobiology at the National Centre for Biological Sciences in Bangalore, India, and lead supervisor of a recent study about the olfactory system that is the first to document the coding is linear. "The pattern and spacing of the clicks make different letters."

In this case, the pattern of the electrical spikes translates to specific smells. But significantly, according to the study, which was published in the journal Nature Neuroscience, when the smell is repeated in the same dose, the pattern remains the same. And when the odor varies in duration, the neurons' electrical response changes proportionately. In other words, the response is orderly and predictable rather than chaotic and irregular.

"Mathematically, it can't be simpler than this," said Priyanka Gupta, a graduate student from the National Centre for Biological Sciences who devised the study and is its lead author. "We can understand what the brain might be doing."

Unlocking how the brain handles a simple process like this can help researchers chip away at how it responds to more complex events, and it can inform technology. Knowing how the brain processes odors, for example, could facilitate the design of artificial noses to detect bombs.

"We have the hope that if there is a glimmer of a simple event, we have the chance to understand complex devices through simple computation," said Dinu Florin Albeanu, a neuroscientist at Cold Spring Harbor Laboratory and another co-author of the study. "It's an entry point."

Neurons are cells that carry messages between the brain and other parts of the body, and when they communicate, they talk to each other simultaneously with electrical pulses that flit hither and thither. Typically, when a stimulus is introduced—sound, for example—all hell breaks loose, and the communication becomes chaotic and more difficult to explain mathematically.

But a study of rats led by Ms. Gupta in Bangalore and at Cold Spring Harbor Laboratory in New York has demonstrated that when their brains decode smells in the first stage of the olfactory system, the process is linear. This allowed the researchers to learn how the brain responded to a smell once and then reliably predict on average how it would respond to the same smell in subsequent exposures.

Rats have many more types of olfactory receptors than humans—1,500 against 350—and they rely more heavily on their sense of smell for survival.

"Animals use their noses in different ways," Mr. Bhalla said. "They sniff more when they are interested in something. There is a time component. The stimulus is patchy. The sample is patchy."

Ms. Gupta controlled for these differences by designing a method to deliver a precise number of molecules of an odor such as mint or banana to the noses of lab rats at specific points in time. She documented the spikes in electrical voltage that occurred in the olfactory bulb in response to the odor. And then she aligned the different pieces of data.

"The spikes in time are not much information until we plot when the odor was on or off," Ms. Gupta said. "We know very precisely when the spikes happened in time. We align that with when we turned on the odor."

The result is the response pattern associated with a particular smell.

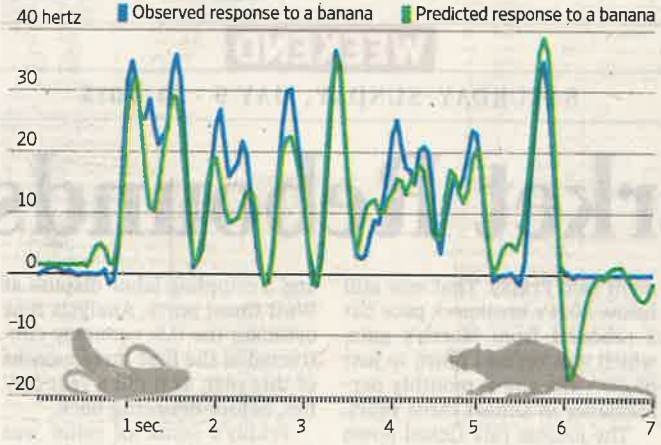
The researchers delivered the odors to anesthetized rats in a steady stream that, thanks to a tracheotomy, wasn't interrupted by exhalation. It is possible that normally functioning, awake animals experiencing complex odors would respond differently.

It is too soon to tell whether others in the field will try to repeat the work or how it may be put to practical use. But if it holds up, it suggests some things may be easier to accomplish than expected.

"Nonlinear information is much harder to interpret," said Venkatesh N. Murthy, a professor of molecular and cellular biology at Harvard who has read the study. "If you can make everything more linear, programs and decoding are more simple. The same analogy holds for the brain."

Nose Job

Neurons in a rat's brain respond to odors by producing electrical spikes. Once the pattern is documented, researchers can predict a neuron's response to subsequent exposures to the smell.



Source: Cold Spring Harbor Laboratory and National Centre for Biological Sciences
THE WALL STREET JOURNAL.

U.S. Watch

GEORGIA

Four Killed in Crash Of Plane on Interstate

Federal investigators say they'll have to reconstruct a plane that crashed into an Atlanta interstate to determine what caused the plane to go down.

Federal Aviation Administration spokesman Kathleen Bergen says a Piper PA-32 took off from DeKalb Peachtree Airport Friday and ran into trouble shortly after.

DeKalb Fire Capt. Eric Jackson says all four people onboard died in the crash. Their identities haven't been released.

National Transportation Safety Board investigator Eric Alleyne said during a news conference that reconstructing the plane may take about two weeks, and a report on the cause of the crash may take between six months and a year.

Mr. Alleyne said it isn't clear if the pilot made any emergency calls after taking off. The crash prompted major traffic backups throughout northeast Atlanta and nearby suburbs.

—Associated Press

NEW YORK

Judge Calls Mistrial In Etan Patz Case

A Manhattan Supreme Court judge on Friday declared a mistrial in the case of a man accused of killing 6-year-old Etan Patz in 1979—a decision that followed more than 10 weeks of testimony and 17 days of jury deliberations.

Justice Maxwell Wiley told the