**Human nose can detect at least 1 trillion odors — far more than thought, says study of smell**

(Zach Veilleux/ Rockefeller University ) - Andreas Keller in the lab surrounded by vials of odors. He and his colleagues used these aromas to measure volunteers' ability to distinguish between scents.



**By Meeri Kim, Updated: Thursday, March 20, 2:00 PM****E-mail the writer**

New-car smell. Fresh-cut grass. Baking bread.

Although our universe of aromas seems infinite, new research shows how many odors our noses can actually detect: at least 1 trillion. The results of the experiment exceeded the most commonly reported guess — 10,000 smells — by a factor of a hundred million.



(Zach Veilleux/Rockefeller University) - A study to measure volunteers' ability to distinguish between odors found that human noses have not been getting the credit they deserve.



While the boundaries of our visual and auditory systems are well-known, this experiment was the first to truly test the limits of the human olfactory system. Our noses exceeded all expectations, given that a trillion smells marked the lower limit of our range. For comparison, our eyes can see a few million different colors, and we can hear about 340,000 tones.

The new study should put an end to the [widely quoted estimate of 10,000 smells](http://www.firstnerve.com/2008/09/10000-different-smells-enough-already.html) — which many researchers didn’t quite believe.

“Ten thousand is kind of pathetic — it’s a pretty low number,” said study author and molecular neurobiologist [Leslie Vosshall](http://vosshall.rockefeller.edu/) of the Rockefeller University. “It led to the idea that humans have a comparatively low sense of smell.”

Using a procedure similar to a hearing exam, in which listeners must try to distinguish between two tones, Vosshall and her colleagues put 26 noses to the test. Each individual was given three vials, two of them containing the same scent, and asked to determine which smell was the odd one out.

After hundreds of these tests on each subject, the researchers assumed that the subjects’ performances would be similar in recognizing all possible smells able to be made in the lab. They extrapolated that the average human should be able to distinguish at least 1 trillion odors. The study was [published online Thursday in Science](http://www.sciencemag.org/embargo?embargoed-uri=http%3A%2F%2Fwww.sciencemag.org%2Fcontent%2F343%2F6177%2F1370).

According to olfactory expert [Avery Gilbert](http://www.averygilbert.com/), who was not involved in the new study, the 10,000-smell estimate stems from an outdated 1927 manuscript by two American chemists. They came up with an odor classification system based on four primary smells — fragrant, acid, burnt and caprylic (goat-smelling) — and suggested that any scent could be formed from those building blocks. Using a nine-point scale for each primary smell, they came up with a total of 6,561 possible different smells. Later, that number was rounded up to 10,000.

“As a number, it says more about bean counting than about the biology of olfaction,” Gilbert said in an e-mail. By contrast, he believes the new “spectacular” number makes sense.

The researchers used a palette of 128 different odor molecules — the simplest building blocks of smells — to create new composite scents. Some of the smells we know best are mosaics made up of hundreds of different odor molecules. For example, the scent of a rose is produced by 275 components working in harmony, and a cup of coffee can contain 400 to 500 — although many are too faint to be detected.

The lab-made composite odors were made up of either 10, 20 or 30 elementary components, such as grapefruit, wintergreen, garbage and garlic, that spanned a wide spectrum of smells. To test olfactory resolution, the team varied the percentage of overlapping components to see how similar two mixtures had to be before subjects could no longer tell the difference.

Predictably, the more building blocks that the scents had in common, the harder it was for the subjects to tell the vials apart. None of the individuals could tell the difference between vials that contained 90 percent of the same components. But surprisingly, the researchers found that the average person can pick out an oddball odor when the overlap is less than about half. After extrapolating to all possible mixtures that could be made, they came up with 1 trillion distinguishable smells.

Olfactory scientist [Joel Mainland](http://www.monell.org/faculty/people/joel_mainland) of the Monell Chemical Senses Center, who was not involved in the experiments, feels certain that this number is only skimming the surface of what our noses can do.

“This is really a lower limit on what you could smell,” Mainland said. “It’s much, much higher than anybody ever thought.”

For instance, he notes that the researchers used a maximum of 30 building block smells, when in reality odors can be made up of hundreds. Also, all the components were set to the same intensity; in reality, some components of a scent will hit the nose more strongly than others.

“Their work confirms that smell is an incredibly rich, variable, and nuanced medium,” Gilbert said. “It’s why you can dive so deeply into the aroma of a wine, when there are only a few ounces in the glass.

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