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Mice can smell greenhouse gas

Rising CO_2 makes a stink for mice.

Katharine Sanderson

Mice can smell carbon dioxide at levels just higher than that in normal air, thanks to specialized neurons in their nose.

Minmin Luo at the National Institute of Biological Sciences, Beijing, and his colleagues tracked down the neurons that mice use to detect carbon dioxide, they write in *Science*[1]. The level of CO_2 above which the mice smelled the gas, they report, was just 0.066% — about twice the average level of CO_2 in the atmosphere (0.038%), but much less than the concentration in exhaled breath (about 4.5%) or the level considered safe for humans (0.5%).

The team targeted neurons in the mouse nose that were already known to express the CO_2-processing enzyme carbonic anhydrase type II (CAII). These cells, called guanylyl cyclase D cells, glowed in the presence of CO_2, showing when mice were picking up the scent.

Get a whiff of that: mice can always smell your breath.

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Carbon dioxide can't be smelled by humans, but other animals have shown an ability to detect relatively high levels of the gas. Insects, too, can detect CO_2, but they do it via membrane receptors rather than through any kind of nose.

Luo's research shows that, to his surprise, in mammals this isn't the case — the mice are literally smelling the gas. "We did not expect it at all," he says. "Most people don't think CO_2 is an odorant. It is used as an irritant, not an olfactory cue."

Something in the air

When mice were exposed to more and more CO_2, their behaviour changed: given a choice between areas of high and low CO_2 concentration, the mice avoided anything higher than 0.2% CO_2.

This could mean that as climate change causes atmospheric CO_2 levels to rise (predicted to be 0.05-0.1% by 2100), changes in mouse behaviour might be spotted. "There will be some behavioural effect," says Luo; but what that effect will be is not known.

Luo's colleague Peter Mombaerts from Rockefeller University, New York says that if the CO_2 increases are gradual, the mice might be able to adapt. "We do that too," he explains, likening it to the way the initial stench encountered on getting into a New York taxi tends to gradually fade. The alternative is a scenario in which mice get more fearful or aggressive as CO_2 levels rise, he says.

Bruce Kimball, from the United States Department of Agriculture, Agricultural Research Service in Maricopa, Arizona, is conducting research in which he artificially elevates CO_2 levels to about twice that in the atmosphere and looks at the effect on plants. He has plenty of stories of mice getting into his shelters, "building nests, chewing wires and peeing on circuit boards," he says, but he hasn't yet noticed any particularly strange behaviour.

Getting higher

Despite their sensitivity, mice aren't going to become modern-day canaries for elevated CO_2. For that to work, mice would have to be genetically engineered so that they don't respond to any other smells, says Mombaerts. Not a very practical solution — particularly when mechanical sensors already exist.

Luo says it is too early to speculate on possible applications of these findings. What is important, he says, is that the olfactory subsystem he has identified is obviously important to mammals, adding that he has also seen the same subsystem in rats and cats.

The exact cellular mechanism for the detection is something Luo's team is now working on. What Luo expects to be important, he says, is the guanylyl cyclase D cell responsible for expressing the CAII enzyme: in humans, who can't smell the gas, the genes that produce the key proteins are present but defective — a fact that Mombaerts finds "intriguing".

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References

1. Hu, J. *et al*. *Science* **317**, 953-957 (2007).

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