Podcast interview: Nate Lewis

Welcome to Science Sessions. I’m Jenny Morber.

**JM:** Among our five senses, our ability to smell is often considered as relatively unimportant. Perhaps this is why scientists still don’t fully understand how human olfaction works. Or perhaps the mystery is due to the sheer complexity of smell. The odor of roasted coffee, for example, is made up of over 670 compounds, and the human nose can distinguish approximately 10,000 odors. Current research suggests that rather than using specific receptors for every odor, human smell relies on recognizing patterns of interactions between receptors and an odor’s many compounds. This pattern is sent to the brain where it matches up to a memory: ah...roasted coffee! For over two decades, professor and researcher Nate Lewis has been working to develop an electronic sensor that mimics this complex chemical recognition—an electronic nose.

**NL:** The mammalian olfactory system does not have a specific receptor for every analyte that it is intended to detect. When you present your odor on a handkerchief to a dog, and then they can trace you versus me, they don’t have any Jenny receptors or Nate Lewis receptors: yet they can do it out of any one of the 200,000,000 people in the country. So they must do that by pattern recognition.

**NL:** A specific odor receptor responds to many different odorants, and in turn any specific odorant elicits a response from many different odor receptors. So, the idea is to copy that architecture. This pattern is preferable to that pattern. This off-odor in packaging is unacceptable because there should be no odor. You trade our ability to make specific odor selectors for instead signal processing on the backend. Signal processing is very powerful and very cheap. And that’s what the electronic, artificial noses are best mated towards.

**JM:** But most of us have noses that work just fine and come well, mostly free. Couldn’t we just have a person sniff around for odors? And isn’t pattern recognition for thousands of compounds still really complicated?

**NL:** We will never break down the odor of Coca Cola into the 200 compounds that are in Coca Cola. But if you’re in a production line and you’re making good Coca Cola, good, good, good, bad: I don’t need to know what the 200 compounds are to tell you it’s different than the good stuff. This is what electronic noses have been used for.

**NL:** For instance, our implementation flew on the space station for six months. They trained it—NASA did—on good cabin air, good cabin air, bad cabin air: You didn’t need a GC mass spectrometer just to tell you there could be a potential change in the environment that likely you want to isolate and then determine if it was really hazardous.
**NL:** It’s probably very useful for hazardous environments like chemical warfare agents on subways. It’s certainly very useful for quality control applications: good meat, good meat, good meat, bad meat because now it has an odor of rotting flesh and rotting meat. So, these broad areas when you just want to use a change detection to tell you that something is different than it was before—and that different generally means bad—these low-power, lightweight systems could be very attractive.

**JM:** So the electronic nose goes places where we can’t go, or don’t want to go, or detects odors that we can’t detect. In 2009, Dr. Lewis received a grant to study the use of an "electronic nose" for breath-based detection of lung cancer. The approach of mimicking biological olfaction seems obvious—and in fact the basic idea has been proposed before. I asked Dr. Lewis if he had any idea why it has taken this long to develop a working prototype of our own sense of smell.

**NL:** I think it’s just important for people to realize that this is really a remarkably exciting time for science. Almost all of these things that we talked about wouldn’t really have even been possible 20 years ago. On the electronic nose, it was a combination of materials, of systems, and signal processing that together synergistically makes this possible. It’s a combination of what we know about biology, of what we’re learning about chemistry, our ability to control materials.

**NL:** In many areas of science our ability to do things now is just so much enhanced, and that opens up, although we have great challenges, really exciting opportunities for scientists and engineers to do things in new ways and make big impacts in those areas.