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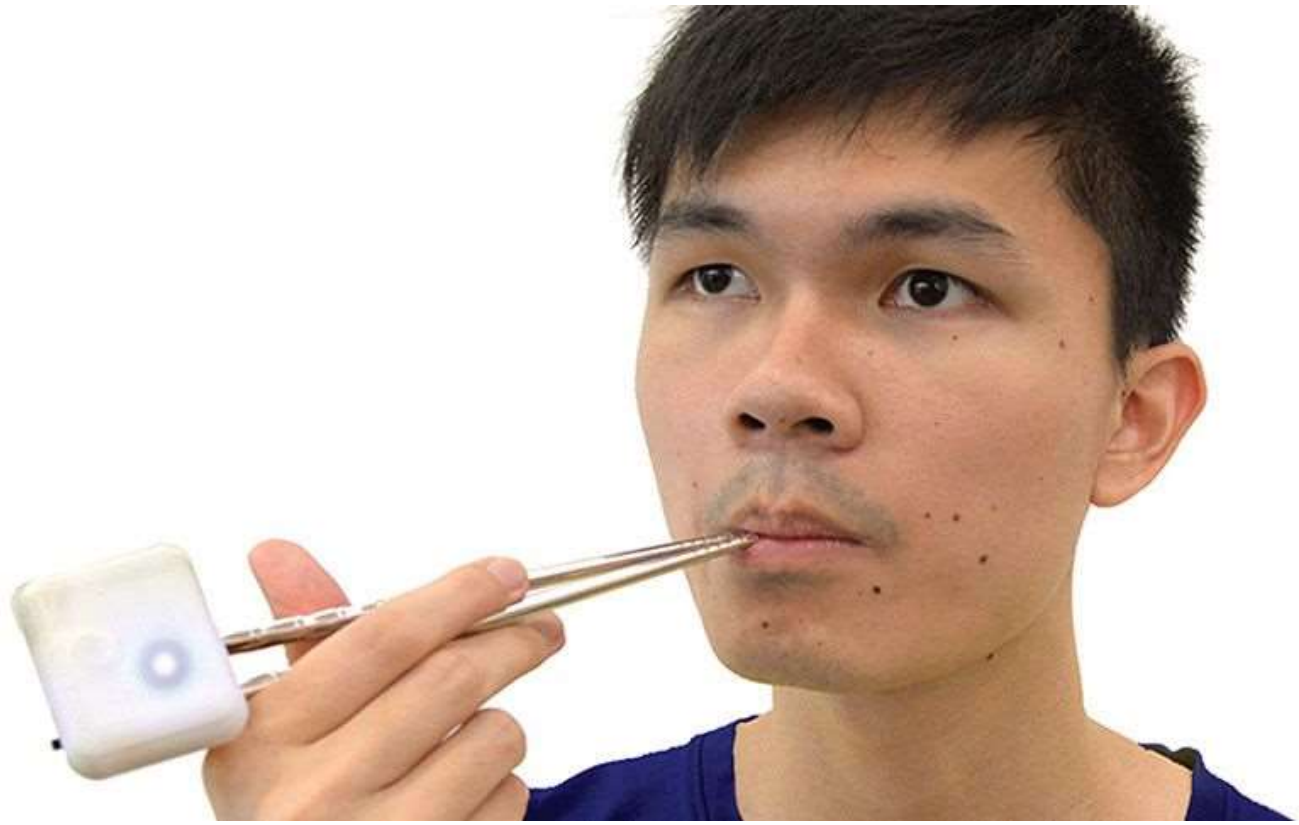
Using Electric Currents to Fool Ourselves Into Tasting Something We're Not

Nimesha Ranasinghe is bringing a new dimension to virtual reality, embedding electric taste simulation technology into utensils



These electrode-embedded chopsticks can simulate saltiness. (Nimesha Ranasinghe)

By Emily Matchar
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It's hard not to think of Nimesha Ranasinghe as a digital age Willy Wonka. But his lab, at the University of Maine, isn't full of chocolate, and it doesn't smell like cotton candy. Instead, the materials of the engineer's work are electrodes and wires, LEDs and pH sensors.

Ranasinghe is one of the world's leading researchers on electric taste simulation—using electronic tools to fool the tongue into experiencing tastes that aren't there. Use his electrode-embedded chopsticks to eat creamy, salty mashed potatoes. Except they're not salted at all—the taste of saltiness comes entirely from the current in the chopsticks. Sip tart yellow lemonade from a tumbler. It's actually not lemonade at all, but plain water colored yellow with an LED, the sourness a result of an electric current running through the cup. Lick a "Virtual Lollipop," and discover what taste your particular biochemical makeup senses—it might be sour, sweet, salty or even bitter. In any case, there's no actual food involved, only silver electrodes.

"I like food," Ranasinghe says. "But the controllability of taste is what I'm really interested and excited about."

Ranasinghe's research involves controlling taste sensations through electricity, color, heat and scent. He envisions a future where simulated tastes could be part of virtual or augmented reality experiences, another step towards comprehensive faux reality.

Originally from Sri Lanka, Ranasinghe has a background in both electrical engineering and computer science. When he arrived at the National University of Singapore to do his PhD, he was interested in figuring out a way to bring senses beyond sight and sound into virtual reality. When he realized there was very little research into electrically simulating tastes, his course of study was set.

"Initially actually I didn't have any idea how to do this," he says. "Unless you have an array of chemicals and put them in the user's mouth. But that didn't sound digital. I was determined to find something totally electrical or totally digital."

Ranasinghe found some papers from the 1970s describing using silver wires to explore the organization of the taste system. Study participants had reported having sour or salty taste sensations when the wires were placed on their tongues. This made sense, Ranasinghe knew, as sour and salty sensations are detected through ion channels.

The other primary tastes—sweet, bitter and umami—are harder to simulate. It's possible, Ranasinghe discovered, to create a minor sense of sweetness through thermal stimulating—exposing the tongue to alternating hot and cold temperatures. Heating and cooling can also simulate perceptions of spiciness or cold, like the feeling of sucking a mint.

"The challenge with thermal stimulation is we need to come up with these heating and cooling mechanisms, and you need to use these bulky heat things [to heat the liquid]," he says. "It's not easy."

Another challenge involved umami—the taste of savoriness found abundantly in foods like parmesan cheese, tomatoes, seaweed and soy sauce. Ranasinghe found that, while most people could easily describe when something was "salty" or "sweet," they had little vocabulary for describing umami. Fearing this would make data collection extremely difficult, he decided to focus on other tastes.

Eventually, Ranasinghe had enough information to try bringing taste simulation technology out of the lab. To do this, he decided to embed the technology into ordinary utensils—chopsticks, bowls, cocktail glasses.

"When I used two silver electrodes, people hesitated to put them inside their mouths," he says.

He experimented with simulated saltiness by having users eat mashed potatoes with electrode-embedded chopsticks. While chopsticks are generally not the utensil of choice for mashed potato eating, he found that users tended to lick the sticky potatoes off the chopsticks, ensuring their tongues came in contact with the electrodes. An electrode-embedded soup bowl was used to enhance the sourness of diluted miso soup, provided the testers drank the soup Japanese-style, mouth to rim.

From here Ranasinghe and his team—first at the Keio-National University of Singapore's Connective Ubiquitous Technology for Embodiments (CUTE) Centre, and now at the University of Maine's Multisensory Interactive Media (MIM) Lab – branched out into exploring how combining other stimuli could change taste and flavor experiences. They created a "Vocktail" (short for "virtual cocktail")—a martini glass with electrodes, scent cartridges and an LED. The drinker can control the sourness or saltiness of the drink in the glass with the electrodes, can add different scents like chocolate, mint, strawberry or banana, and can change the color with the LED. Users could create a sour, green-colored mint mojito or a salty-sour red-colored strawberry margarita. All out of plain water.

There are several potential real-world applications for the technology, Ranasinghe says. First, there's the health angle: the technologies could be used to help people decrease salt or sugar in their diets by fooling the taste buds. It could also help those with diminished capacity for taste—chemotherapy patients, for example, or the elderly—to enjoy food again. Second, flavor houses—companies that develop and produce flavorings for the food and beverage industry—could use a taste simulator to get instant tester feedback on flavor profiles (drink too sour? How about now?). Third has to do with virtual or augmented reality: how cool would it be to be able to actually "taste" a slice of cake as you're wandering a virtual recreation of a 19th century Viennese pastry shop? Or sip a glowing cup of alien grog as you explore a far-off planet?

Matthias Harders, co-author of the book *Virtual Reality in Medicine*, speculates that taste technology incorporated into VR might one day be used to help treat eating disorders.

"But the technology is still too rudimentary to see a clear benefit in medicine," he says.

Harders thinks we'll see smell technology incorporated into virtual reality much sooner than taste technology. Some ultra-high-tech movie theaters, he points out, are already using smell technology to enhance viewers' experiences (theaters have in fact been using smell for nearly 100 years, from piping in perfume during a romantic play to the infamous Smell-o-Vision of the 1960s).

Adrian David Cheok, a professor of computing at the City University of London who works on taste simulation, agrees.

"We actually smell our food," he says. "In the long run it's going to be more important to simulate smell."

Cheok, who served as Ranasinghe's PhD advisor, imagines work like his and Ranasinghe's could connect people in unexpected ways. People living far from family sometimes set up Skype while they eat, he says, to "share" dinner with loved ones. But what if they could actually share the smell and taste as well? Taste and smell technology could also be a learning aid in schools or museums, he says.

"Imagine you could also taste and smell the foods that people ate in ancient Rome?" he says.

Though Cheok says current work on taste simulation is rather limited, there are a few researchers besides himself and Ranasinghe. Japanese researchers developed a Food Simulator that fits in the mouth, allowing the user the sensation of chewing while an in-ear speaker simultaneously delivers appropriate noises (crunching if you're meant to be chewing a cracker, for example). At the same time, the mouthpiece squirts in tiny jets of chemicals to represented the five basic tastes. Another device, 2005's TasteScreen, uses chemical flavoring cartridges to deliver flavors to a computer screen. Created by a then-Stanford grad student, it allows users to literally lick the screen to taste what they're seeing.

It will take far more than stimulating the taste buds (or squirting chemicals on a computer screen) to recreate the taste of real food from scratch. While sour, sweet, salty, bitter and umami are tastes detected by the tongue, the experience of eating involves flavor and mouthfeel as well. Flavor—think roasted, fruity or floral—involves the sense of smell, and texture (creamy, crunchy, chewy) is about our sense of touch.

Ranasinghe's future work involves all of this. He's interested in using olfactory and haptic technology to incorporate smell and touch in VR taste experiences. Imagine sipping "coffee" in a virtual office while coffee scent is piped in and tactile sensors give you the feeling of shaking real sugar into your mug, which is blowing warm air into your nostrils to feel like steam.

Sound like magic?

As Willy Wonka said: "Invention, my dear friends, is 93 percent perspiration, 6 percent electricity, 4 percent evaporation, and 2 percent butterscotch ripple."

In Ranasinghe's case, it's heavier on the electricity, but no less inventive.

About Emily Matchar

Emily Matchar is a writer based in Hong Kong and Chapel Hill, North Carolina. Her work has appeared in *The New York Times*, *The Atlantic*, *The New Republic*, *The Washington Post* and other publications. She is the author of .