COGNITIVE SCIENCE

WHAT MAKES FOOD TASTE SO GOOD?

Deliciousness is the happy result of a surprising mélange of factors, some of which have nothing to do with your taste buds

By Michael Moyer

TASTE IS NOT WHAT YOU THINK. EVERY SCHOOLCHILD LEARNS THAT IT IS ONE OF THE FIVE senses, a partner of smell and sight and touch, a consequence of food flitting over taste buds that send important signals—sweet or bitter, nutrient or poison?—to the brain. Were it so simple. In the past decade our understanding of taste and flavor has exploded with revelations of the myriad and complex ways that food messes with our consciousness—and of all the ways that our biases filter the taste experience. Deliciousness is both ingrained and learned, both personal and universal. It is a product of all five senses (hearing included) interacting in unexpected ways, those sensory signals subject to gross revision as they are integrated by the brain into one complex, sometimes wonderful perception.

IN BRIEF

Flavor is a complex perception that the brain constructs by combining a wide range of sensory inputs—sights, sounds, smells and textures among them—with memories, social cues and hardwired instincts.

Certain foods taste better together, some scientists believe, when they have a large number of flavor compounds in common. To test this idea, researchers have mapped the chemical connections among common foods.

Photograph by Dan Saelinger

Research into why we love some foods more than others points to a combination of factors that include, among other things, looks, smells, sounds and even past experiences.

Let's start at the beginning: Food enters your mouth, meets your teeth and begins to be broken down by enzymes in your saliva. The morsel soon moves over your papillae, the few thousand bumps that line your tongue. ❶

Each papilla houses onionlike structures of 50 to 100 taste cells folded together like the petals of a young flower about to bloom—taste *buds,* we call them. These cells have chemical receptors attuned to the five basic tastes—bitter, sweet, sour, salt and umami, the last a word borrowed from Japanese that describes the savory flavors of roast meat and soy sauce. ❷

These five tastes are enough to help determine if the thing we just put into our mouth should go any farther—if it's sweet or savory and thus a probable source of nutrients or if it's bitter and potentially poisonous. Yet they can't get close to communicating the complexity of the flavors that we sense.

For that, we turn to the nose. As you take in a piece of food, a little air is forced up passageways at the back of the mouth, where scent receptors in the nasal cavity detect thousands of volatile chemicals that add up to complex flavors. This retronasal olfaction, as it is called, has almost nothing to do, physiologically, with the act of sniffing your food. Your brain knows where your smell signals are coming from—through your nostrils or from your mouth. And in the case of the latter, it ropes them together with the signals from the taste buds. Retronasal olfaction produces a completely unique sense—neither smell nor taste alone but a hybrid that we call flavor. It is a process as transformative and irreversible as turning fuel and oxygen into flame.

Our sense of taste doesn't end at the mouth. In recent years scientists have found taste receptors all over the body, discoveries that have solved some longstanding mysteries. For 50 years scientists had been trying to figure out why eating glucose produces a much sharper insulin release than injecting the same amount of

❶ That tongue "taste map" your schoolteachers taught you? Forget it. The map was based on a misunderstood diagram in a 1901 paper.

❷ Some researchers argue that we should expand the list to include fatty, metallic and kokumi, which translates to "mouthfulness" or "heartiness."

glucose directly into the bloodstream. In 2007 they discovered that cells lining the small intestine also contain taste receptors. When these intestinal sweet sensors detect sugar, they trigger a cascade of hormones that ultimately ends with a squirt of extra insulin into the bloodstream. ❸

Our sense of taste isn't just limited to the mouth and the gut. For example, your nose is lined with cells that sense bitter chemicals. If there is poison in the air, they reflexively stop you from pulling it into your lungs. If the poison does get to the throat, bitter detectors in the trachea trigger cilia to help clear the airway. ❹

This physiology may explain what we mean by flavor—but anatomy doesn't much help us understand what we like. Our flavor preferences take shape over a lifetime, beginning while we are still in the womb. Babies whose mothers consume garlic while pregnant are more likely to enjoy the flavor of garlic in breast milk. Pregnant women who drink carrot juice are more likely to have kids who like carrots. ❺ The evolutionary justification is simple enough: if Mom ate it, it's safe.

Indeed, we use our friends and loved ones in much the same way that medieval monarchs used food tasters—let them try it first, then let's see how they are doing in 20 minutes. The principle holds all the way down the food chain. Rats hate the taste of cocoa, ❻ yet some enterprising scientists recently separated a rat from its brood and coaxed it to eat some anyway. The rat then returned to its group. When the other rats smelled the cocoa on

❸ Amazingly, these taste receptors are just as fooled by artificial sweeteners as your tongue is—NutraSweet also leads to a surge of insulin.

❹ The more they look, the more researchers are finding taste receptors in the most unlikeliest of places. Sweet receptors line the bladder. Your spine has sour receptors. And most bizarrely, the testes have the capacity to sense bitter taste, whereas sperm can detect umami.

❺ The same has been tested for anise, mint, vanilla and every kid's favorite: blue cheese.

❻ The unsweetened variety—too bitter, presumably.

PROP STYLING BY DOMINIQUE BAYNES

its breath, they changed their minds and suddenly couldn't get enough cocoa.

Children are harder to convince—they have to try an unfamiliar food about nine times, on average, before they begin to like the taste. ❼ As any parent will attest, so much of the eventual enjoyment rests on how well Mom and Dad sell it. Moreover, the same holds true for adults—hence decades of increasingly sophisticated food-marketing campaigns.

The environment sends many cues about how food should taste. In one experiment, researchers connected volunteers' tongues to a low-voltage electrical device, showed them pictures of food items and then sent a mild shock across their taste buds—a sensation not unlike licking a battery. The shock was supposed to impart a neutral taste. Asked afterward to rate how pleasurable the shock was, those volunteers who saw photographs of sweet or fatty foods rated the stimulus far more pleasurable than those who saw a low-calorie food.

The visual and auditory triggers can be so obvious as to appear comical. Potato chips taste crisper if you hear a crunch over headphones. White wine with a drop of red food coloring tastes like red wine—even to experienced wine tasters. People will eat less food off of a red plate. A block of cheese with sharp edges tastes sharper than one with round corners.

It's not all from our mouth, or our mouth and the back of our nose, or our mouth, and nose, and taste cells in the intestine. Deliciousness comes from our mother, our childhood, the room we are eating in, the plates we are eating on and the friends we are eating with. It's mental as much as chemical. Flavor starts in food, yes, but it is also something that is ours to create, everyday. SA

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❼ Your mileage may vary.

MORE TO EXPLORE

Taste: Making Sense of Flavour. Special issue of *Nature*, Vol. 486, Supplement, pages S1–S43; June 21, 2012.

Can We Feed the World? The Future of Food. *Scientific American* e-book available from http://books.scientificamerican.com/sa-ebooks

scientificamerican.com/magazine/sa

TASTE MAP

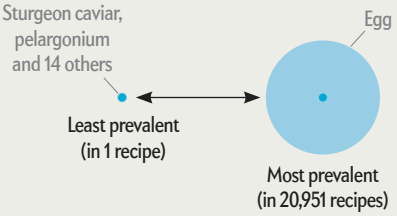
The Flavor Connection

Julia Child famously said that fat carries flavor, but perhaps instead we should give thanks to 4-methylpentanoic acid. Unique combinations of such chemical compounds give foods their characteristic flavors. Science-minded chefs have gone so far as to suggest that seemingly incongruous ingredients—chocolate and blue cheese, for example—will taste great together as long as they have enough flavor compounds in common. Scientists have put this hypothesis to the test by creating a flavor map, a variant of which we have reproduced here. Lines connect foods that have components in common; thick lines mean many components are shared. By comparing the flavor network with various recipe databases, the researchers conclude that chefs do tend to pair ingredients with shared flavor compounds—but only in Western cuisine. Dishes from a database of recipes from East Asia tend to combine ingredients with few overlapping flavors.

How to Read This Graphic

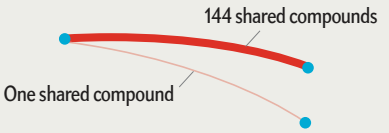
Each blue dot is a food. Similar foods are grouped into 14 category columns (*listed in alphabetical order*).

The size of a dot shows how popular the food is—the frequency with which it appears in a global 56,498-recipe database.



Of all the foods that share flavors outside of their own categories (and excluding roasted peanuts/peanut butter), beer and roasted beef have the most in common: 106. Close behind are apples/white wine and coffee/roasted beef, both with 105.

A line connecting two dots means the two foods share at least one flavor-related chemical compound. The more flavor compounds they share, the thicker the line. Red lines connect foods in different categories.



Wine and cheese contain many of the same flavor-producing chemicals.

Gray lines connect foods in the same category.

A food's vertical position on the page reveals the total number of foods that connect to it. Foods at the top of the page share flavor compounds with many other foods. Foods at the bottom of the page are completely unique—they do not share flavors with any other foods.

Because of space constraints, only the most popular ingredient in a cluster of dots is labeled.

Eggs, flour and butter were the three most popular ingredients, each appearing in more than 20,000 recipes. Rounding out the top 10: onion, garlic, milk, vegetable oil, cream, tomato and olive oil.

SOURCE: "FLAVOR NETWORK AND THE PRINCIPLES OF FOOD PAIRING," BY YONG-YEOL AHN, SEBASTIAN E. AHNERT, JAMES P. BAGROW AND ALBERT-LÁSZLÓ BARABÁSI, IN *SCIENTIFIC REPORTS*, VOL. 1, ARTICLE NO. 196, DECEMBER 15, 2011. WITH THANKS TO SEBASTIAN AHNERT

Graphic by Jan Willem Tulp