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The Scent of Flavor

[Linda Bartoshuk](https://inference-review.com/contributor/linda-bartoshuk)

ARISTOTLE CONCLUDED that there are five elementary sensations: sight, hearing, touch—encompassing temperature, irritation, and pain—taste, and smell. He was mistaken.

When Aristotle sniffed an apple, he smelled it. When he bit into the apple and the flesh touched his tongue, he tasted it. But he overlooked something that caused 2,000 years of confusion.[1](https://inference-review.com/article/the-scent-of-flavor#endnote-1) If Aristotle had plugged his nose when he tasted the apple, he might have noticed that the apple sensation disappeared leaving only sweetness and perhaps some sourness—depending on the apple. He might have decided that the apple sensation was entirely different from the sweet and sour tastes, and he might have decided that there are six elementary sensations. He didn’t. It was not until 1810 that William Prout, then a young student at the University of Edinburgh, plugged his nose and noticed that he could not taste nutmeg. He wrote,

[T]he sensation produced by the nutmeg or any other substance, when introduced into the mouth, and which ceases the moment the nostrils are closed, is really very different from taste, and ought to be distinguished by another name; that that name should be *flavor* [emphasis original], the one which seems most naturally and properly to designate it.[2](https://inference-review.com/article/the-scent-of-flavor#endnote-2)

We now understand the anatomy of the nose and mouth. There is a conduit from the back of the mouth up into the nose called the retronasal space. When we swallow, volatiles released from foods in the mouth are forced through the retronasal space, up into the nose. The perception of those volatiles gives us flavor. If you plug your nose, air currents cannot move through the retronasal space and flavor is blocked.

If Aristotle had recognized flavor as a distinct sensation, he might have paid attention to how taste, flavor, and smell really work together. Taste handles the sensations evoked when nonvolatiles stimulate receptors on the tongue. Flavor and smell respond to volatiles that stimulate receptors in the nose and send signals up **the olfactory nerve**. But those signals are processed in different parts of the brain.[3](https://inference-review.com/article/the-scent-of-flavor#endnote-3) Smell tells us about objects in the world around us and flavor tells us about foods in our mouths. Smell and flavor cannot both use the olfactory nerve at the same time; they must take turns.

**The brain needs to know which of the senses is using the [olfactory] nerve in order to send the input to the correct area.**

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| **Sniffing** appears to be the cue that  | **signals smell**.[4](https://inference-review.com/article/the-scent-of-flavor#endnote-4)  |
| **Taste** appears to be the main cue that  | signals **flavor**.  |

The evidence for this, documented below, took a long time to gather, but the search has yielded many important insights with clinical and commercial implications.

The Victim of an Illusion

ARISTOTLE’S MISTAKE is understandable when we consider that retronasal olfactory sensations, or flavors, seem to come from the mouth even though we know they come from the nose. Consider the following demonstration. Plug your nose and put a jelly bean in your mouth. Chew it up and swallow it while keeping your nose tightly closed. You will probably taste sweetness and perhaps a bit of sourness, depending on the jelly bean, but you will not perceive the flavor. That is, you won’t know if the jelly bean is lemon flavored, lime flavored, raspberry flavored, or so on. Now unplug your nose. Suddenly you will perceive the flavor. When you unplugged your nose, the volatiles released by chewing the jelly bean traveled up through the retronasal space into your nose and produced a signal in your olfactory nerve that traveled to your brain.

Think about that moment when you perceived the flavor of the jelly bean. You perceived that flavor as coming from your mouth. Even knowing that the volatiles travel into your nose and the flavor sensation comes from your olfactory nerve, you will still perceive it as coming from your mouth. In 1917, two psychologists, Harry Hollingworth and Albert Poffenberger, became fascinated by this illusion. In their book, *The Sense of Taste*, they explained the localization of flavor to the mouth as, “true largely because of the customary presence of sensations of pressure, temperature, movement, and resistance which are localized in the mouth.”[5](https://inference-review.com/article/the-scent-of-flavor#endnote-5)

This conclusion went unchallenged for decades. Research elsewhere supported the idea that the touch sense controls the localization for other sensations. For example, touch controls the localization of thermal stimuli. To demonstrate this, place two quarters in your freezer to make them cold. Hold one in your hand to make it body temperature. Arrange the three quarters on a flat surface with the body-temperature quarter in the middle. Touch the three quarters simultaneously with your index, middle, and ring fingers. All three quarters will feel cold. The touch sensations “capture” the cold sensation so that coldness seems to come from all three quarters.[6](https://inference-review.com/article/the-scent-of-flavor#endnote-6)

The Localization of Flavor

WE ARE now able to anesthetize **the chorda tympani taste nerve** that mediates taste from the front, mobile part of the tongue. The chorda tympani nerve leaves the tongue in a common sheath with **the trigeminal nerve**, which mediates touch, temperature, irritation, and pain on the tongue. These nerves travel near the nerve mediating pain from lower teeth. When your dentist gives you an injection of lidocaine to block pain when filling a lower tooth, the nearby trigeminal and chorda tympani nerves are also anesthetized. As a result, your tongue becomes numb and you cannot taste on the side of the injection.

The chorda tympani and lingual nerves separate, and the chorda tympani passes through the middle ear, right behind the eardrum, before it travels to the brain. When otolaryngologists anesthetize the eardrum, they also inadvertently anesthetize the chorda tympani nerve.

As part of a study, we asked volunteers to sample yogurt and tell us where they perceived the flavor. The answer: from all around the inside of the mouth. Whether we anesthetized the chorda tympani taste nerve by dental injection—blocking taste and touch—or otolaryngological injection—blocking only taste—the result was the same. In both cases the flavor jumped to the unanesthetized side of the mouth.[7](https://inference-review.com/article/the-scent-of-flavor#endnote-7) Our conclusion was that touch was less important: taste controls the perceptual localization of flavor to the mouth.

Is there any biological purpose served by the flavor localization illusion? Olfaction senses objects in the world outside of us, but also senses objects in our mouths.[8](https://inference-review.com/article/the-scent-of-flavor#endnote-8) We perceptually localize smells to objects in the world around us. Perceptually localizing both taste and flavor to the mouth emphasizes both as attributes of food.

Taste and Flavor Distinction

PROUT’S INSIGHTFUL distinction between taste and flavor did not gain much traction. The only reference to it by his peers that I have ever found is a footnote written by his friend John Elliotson in his translation of a famous Latin text by Johann Friedrich Blumenbach, *Institutiones Physiologicae* (The Elements of Physiology).[9](https://inference-review.com/article/the-scent-of-flavor#endnote-9) Prout gained his real renown for work in physical chemistry on the hydrogen atom. His work so impressed Ernest Rutherford that the proton was almost named the “prouton.”[10](https://inference-review.com/article/the-scent-of-flavor#endnote-10)

Prout was not the only scientist to plug his nose in an effort to discover the origin of flavor. In France, just a few years after Prout, two other scientists, the anatomist Hippolyte Cloquet and the chemist Michel Eugène Chevreul,[11](https://inference-review.com/article/the-scent-of-flavor%22%20%5Cl%20%22endnote-11) made similar observations. The Scottish philosopher Alexander Bain, one of the earliest to consider psychology a science, demonstrated his increasingly sophisticated understanding of flavor across the three editions of his book, *The Senses and the Intellect*.[12](https://inference-review.com/article/the-scent-of-flavor#endnote-12) In the 1855 edition, “flavour” was “the mixed effect of taste and odour,”[13](https://inference-review.com/article/the-scent-of-flavor#endnote-13) but in 1864, Bain noted that tastes are “the same whether the nostrils are opened or closed,”[14](https://inference-review.com/article/the-scent-of-flavor#endnote-14) and flavor results when “odorous particles are carried into the cavities of the nose” and ceases when the nostrils are closed. As it turned out, these observations had almost as little impact as Prout’s.

**The distinction between taste and flavor** became blurred over the course of the twentieth century. The Arthur D. Little company in Boston was the first to market a method for flavor evaluation for the food industry. In 1945, *Flavor*, written by Ernest Crocker, a chemist working at Arthur D. Little, was published.[15](https://inference-review.com/article/the-scent-of-flavor#endnote-15) Crocker used the word “flavor” to denote the aggregation of all the sensations evoked by eating: taste, olfaction, and touch; like Aristotle, Crocker lumped temperature, irritation, and pain in with touch. The sensations evoked when volatiles rise through the retronasal space into the nose were acknowledged to occur but were described simply as a “back entry” for the detection of odors.

Confusion about the sensation evoked by the travel of volatiles through that “back entry” are reflected in the terms used to describe it. We now use “retronasal olfaction,” but that term did not appear in a published paper until 1984.[16](https://inference-review.com/article/the-scent-of-flavor#endnote-16) Prior to that, an array of terms had been suggested: “nose sensations,”[17](https://inference-review.com/article/the-scent-of-flavor#endnote-17) “*Gustatorische Reichen*” (gustatory smelling),[18](https://inference-review.com/article/the-scent-of-flavor#endnote-18) “expiratory smelling,”[19](https://inference-review.com/article/the-scent-of-flavor#endnote-19) “nasal chemoreception,”[20](https://inference-review.com/article/the-scent-of-flavor#endnote-20) and “in-mouth olfaction,”[21](https://inference-review.com/article/the-scent-of-flavor#endnote-21) to name the ones I’ve found.

Robert Moncrieff wrote *The Chemical Senses* in 1944. The updated edition published in 1960 was considered the standard text for graduate students in my era. Like the position taken at Arthur D. Little, Moncrieff wrote:

Flavour is a complex sensation. It comprises taste, odour, roughness or smoothness, hotness or coldness, and pungency or blandness. The factor which has the greatest influence is odour. If odour is lacking, then the food loses its flavour and becomes chiefly bitter, sweet, sour or saline.[22](https://inference-review.com/article/the-scent-of-flavor#endnote-22)

At least Moncrieff argued that odor was the most important.

The International Standards Organization (ISO) is a federation of groups that set standards reflecting the views of at least 75% of the member bodies voting. The ISO definition of flavor is short but far from sweet: “Flavour: complex combination of the olfactory, gustatory and trigeminal sensations perceived during tasting.”[23](https://inference-review.com/article/the-scent-of-flavor#endnote-23) Dictionaries do much the same. Merriam-Webster defines “flavor” as, “The quality of something that affects the sense of taste,” and, “The blend of taste and smell sensations evoked by a substance in the mouth.”[24](https://inference-review.com/article/the-scent-of-flavor#endnote-24)

Part of the reason for this confusion is that we lack a verb to describe the perception of flavor. Consider how we describe the sensations evoked by taste, smell, and flavor. I can say, “I taste sugar” and “I smell cinnamon,” but not “I flavor cinnamon.” Using “flavor” as a verb means to add flavor to something rather than to perceive the sensation of flavor. When we want to describe how we perceive the flavor of cinnamon we borrow “taste” and say, “I taste cinnamon.” This only adds to the problem.

An Aggregate of All Sensations

SOME EXPERTS that use **“flavor”** to describe the aggregate of all sensations evoked by eating have argued that this aggregation has a unitary property. That is, the sensations evoked by eating combine to create something that is different from any of them, i.e., an emergent property. The nature of emergent properties arising from combinations of different sensations has been addressed by Michael Kubovy and David Van Valkenburg.[25](https://inference-review.com/article/the-scent-of-flavor#endnote-25)

An emergent property of an aggregate is a [an (more abstract) ontological] property that is not present in the aggregated elements. At room temperature, for example, water is a liquid, but the elements that compose it are both gases. Thus, at room temperature, the property *liquid* is an emergent property of water. There are two kinds of emergent properties: *eliminative* and *preservative*. When hydrogen and oxygen combine to form water, the properties of the elements, both being gasses, are not observable; they are eliminated by the process of aggregation. In the human sciences, such eliminative emergent properties are also common: we can mix two colored lights, such as red and yellow, and observers will not be able to tell whether the orange light they observe is a spectral orange or a mixture. Thus, color mixture is an eliminative emergent property. Preservative emergent properties were first noticed in 1890 by Christian von Ehrenfels,[26](https://inference-review.com/article/the-scent-of-flavor%22%20%5Cl%20%22endnote-26) who described a *melody*as being an emergent property of the set of notes comprising it. The notes can be heard; indeed they *must* be heard for the melody to be recognized. In a melody, the elements are preserved in the process of aggregation; indeed, the emergence of the melody is conditional upon the audibility of the elements.

Even when “flavor” is considered to emerge from the aggregate of all the sensations evoked by eating, most agree that those individual sensations remain perceptible. In *The Psychology of Flavor*, Richard Stevenson explicitly notes that flavor is a “preservative emergent property.”[27](https://inference-review.com/article/the-scent-of-flavor#endnote-27)

I wish that Crocker and the Arthur D. Little company had coined a new name for the aggregation of the sensations evoked by eating. As a result of this oversight, we are left with two meanings for the word “flavor.” There is little that we can do about this now except to point out that “flavor” can be used to denote retronasal olfaction, or the emergent property of the aggregate of sensations evoked by eating. For the remainder of this article, “flavor” refers to retronasal olfaction.

The Lady Who Could Not Taste Lasagna

NUMEROUS STUDIES have shown that altering the intensity of taste alters the intensity of flavor. The first hint of this dynamic was observed in a patient who cut her tongue licking chocolate pudding out of a can with a sharp edge. I asked the patient to describe what she had lost. She told me that her mother-in-law was a superb Italian cook. She described the wonderful smell she experienced coming from her mother-in-law’s lasagna and the terrible disappointment she felt when she took a bite and perceived nothing. This insight caught my attention because I knew that if the patient could smell the lasagna, her olfactory system was intact, and she should have experienced retronasal olfaction—the flavor of the lasagna. I worried about the possibility that the woman was lying in order to get me to testify in court on her behalf. Indeed, she was then in the process of suing the manufacturer of the can that cut her tongue. Nonetheless, I found her account convincing.

I decided to see if I could duplicate her experience with anesthesia. I ate half a chocolate bar and perceived the usual chocolate sensation I had learned to love as a child. I then anesthetized my mouth by rinsing with the topical anesthetic Dyclone and ate the other half of the chocolate bar. Most of the chocolate sensation was gone. The patient who could no longer taste her mother-in-law’s lasagna was right: if taste is taken away, something goes awry with flavor.

One of my students, Derek Snyder, pursued this topic in his PhD thesis, working with clinical colleagues who used unilateral and bilateral injected anesthesia—dental and otolaryngological—as well as topically applied anesthesia to block taste in volunteers. Blocking taste on only one side of the tongue caused retronasal olfactory sensations to drop by 25%. Blocking taste on both sides led to a drop of 50%. Smell sensations were unchanged.[28](https://inference-review.com/article/the-scent-of-flavor#endnote-28)

Some individuals experience much more intense taste sensations than do others because of genetic variation—we call these individuals “supertasters”[29](https://inference-review.com/article/the-scent-of-flavor#endnote-29)— and some individuals experience altered taste sensations arising from clinical pathologies.[30](https://inference-review.com/article/the-scent-of-flavor#endnote-30) The intensity of our taste sensations predicts the intensity of flavor sensations independent of the ability to smell.[31](https://inference-review.com/article/the-scent-of-flavor#endnote-31) If supertasters and non-supertasters both sniff a bowl of chocolate pudding, the two groups will experience, on average, the same chocolate smell. But if both groups eat the pudding, the supertasters will experience the more intense chocolate flavor.

Two taste modifiers also reveal the link between taste and flavor. *Gymnema sylvestre* is an Indian herb that blocks sweet taste. Medicinal use of this herb dates back two thousand years in Ayurvedic medicine. The ability of *Gymnema sylvestre* to block sweetness was revealed to the Western world by a nineteenth-century Irish botanist, Michael Edgeworth, while he was working in India. On the advice of neighbors, he chewed the leaves of the plant and discovered he could not taste the sugar in his tea. In 1847, Edgeworth wrote a letter to a fellow botanist, telling him about *Gymnema sylvestre*.[32](https://inference-review.com/article/the-scent-of-flavor#endnote-32) The letter was read at the Linnean Society in London and ultimately described in more detail in the*Pharmaceutical Journal*.[33](https://inference-review.com/article/the-scent-of-flavor#endnote-33)

As part of a study, we made tea from *Gymnema sylvestre* leaves. Volunteers rinsed their mouths with this tea and then sampled maple syrup and chocolate kisses. The sweetness was substantially reduced, and the maple and chocolate sensations were substantially reduced as well.[34](https://inference-review.com/article/the-scent-of-flavor#endnote-34) Recovery from the effects of *Gymnema sylvestre* also demonstrated the link. The sweetness of sugar syrups made with maple, orange, and raspberry flavors were blocked. As the ability to taste sweetness recovered from the effects of *Gymnema sylvestre*, the sensations of maple, orange, and raspberry recovered at essentially the same pace.[35](https://inference-review.com/article/the-scent-of-flavor#endnote-35) Anyone who wants to experience the effects of *Gymnema sylvestre*can find it online.

The second taste modifier came from berries found on the *Synsepalum dulcificum* bush, commonly known as miracle fruit. These berries were first described in English by Archibald Dalzel in 1793. Trained as a physician, but not very successful at it, he found himself in need of money and turned to slave trading in Africa. Dalzel’s observations of the local life where he lived in Africa led to a book, *The History of Dahomy*, in which he describes a “miraculous berry” that can convert “acids to sweets.”[36](https://inference-review.com/article/the-scent-of-flavor#endnote-36) Consumption of the berries were first mentioned more than a century earlier in Wilhelm Müller’s *Die Africanische Auf der Guineishen Gold-Cust Gelegene Landschafft Fetu*(The African on the Guinean Gold-Coast Landscape, Kingdom of Fetu).[37](https://inference-review.com/article/the-scent-of-flavor#endnote-37) The berries were presumably known and used long before that. One of the most interesting uses of miracle fruit in Africa during the nineteenth century was to sweeten palm wine that had turned sour during the long journey from distillation to market.[38](https://inference-review.com/article/the-scent-of-flavor#endnote-38)

The glycoprotein responsible for the effects of miracle fruit remains intact when the berries are freeze dried. We asked volunteers to let freeze-dried tablets of miracle fruit dissolve on their tongues. The miracle fruit increased the sweetness of tomatoes and strawberries, both foods that contain acid. That increase in sweetness also increased the tomato and strawberry flavors.[39](https://inference-review.com/article/the-scent-of-flavor#endnote-39) As is the case with *Gymnema* *sylvestre*, anyone wishing to experience these effects can purchase tablets made from the freeze-dried berries online.

Recently, I had a video call with a very important patient: a young woman who had lost the ability to taste, but still retained her sense of smell. Although she is unable to perceive flavors, there may still be a role for some trigeminal sensation. This patient is unable to feel the burn of chilis, but she can perceive touch on her tongue. Thus, there is still a chance that some trigeminal sensations may also open or close the flavor door.[40](https://inference-review.com/article/the-scent-of-flavor#endnote-40)

Together, these studies show that taste and retronasal olfaction are distinct sensations that remain distinct even though their perceived intensities are altered in mixtures of the two. Presumably, this occurs in a part of the brain that receives input from both sensations.[41](https://inference-review.com/article/the-scent-of-flavor#endnote-41) Taste is not perceptually a part of retronasal olfaction, but rather signals that an incoming olfactory signal should be processed as flavor rather than smell. The taste cue acts like a valve that lets the retronasal olfactory signal pass through or obstructs it to the degree the valve is open or shut.

Following the Scent of Flavor

RESEARCHERS IN the food industry knew that intensifying taste can intensify flavor as early as the 1950s.[42](https://inference-review.com/article/the-scent-of-flavor#endnote-42) Rose Marie Pangborn, for example, showed that adding sucrose to apricot juice intensified the apricot sensation.[43](https://inference-review.com/article/the-scent-of-flavor#endnote-43) The reverse effect, intensification of sweetness by retronasal perception of volatiles, was found a bit later. One of the earliest hints came from an experiment we undertook during 1977 in which the addition of ethyl butyrate (fruity flavor) increased the taste of saccharin.[44](https://inference-review.com/article/the-scent-of-flavor#endnote-44) Another hint came from a horticultural study linking the sweetness of tomatoes to specific volatiles present in the tomatoes.[45](https://inference-review.com/article/the-scent-of-flavor#endnote-45) In the following forty years, only a few volatiles were identified that could enhance sweetness, and the effects were quite small.

After leaving Yale for the sunny skies of the University of Florida in the early-2000s, I met Harry Klee, a botanist and world expert on the volatiles in tomatoes. Over the course of the twentieth century, tomatoes were bred to look and ship better with little regard for their palatability.[46](https://inference-review.com/article/the-scent-of-flavor#endnote-46) This led to a decline in the flavors of tomatoes. Klee wanted to halt this process and restore highly palatable flavors to the tomato. Howard Moskowitz, a Harvard-trained sensory psychologist who had left academia for the food industry, was an expert at improving the flavors of food products using psychophysics and mathematics. His success with spaghetti sauce was chronicled by Malcolm Gladwell in a *New Yorker* article.[47](https://inference-review.com/article/the-scent-of-flavor#endnote-47) I asked him if he would be willing to work with us on **tomatoes**.

Moskowitz was fascinated by the possibility of applying his techniques from marketing research to the natural world. We grew 150 different varieties of tomatoes that were **mostly heirlooms, that is, tomatoes with a lot of genetic diversity**. The tomatoes were analyzed for their chemical content—sugars, acids, volatiles—along with their sensory and hedonic properties—smell, taste, flavor, palatability. We used a method that provides valid comparisons for the perceived intensities of sensations across different people: essential when sensory intensities are to be associated with physical measures.[48](https://inference-review.com/article/the-scent-of-flavor#endnote-48) The data were then put into a multiple regression model, allowing us to identify which tomatoes were liked the best and which constituents made them the most liked.[49](https://inference-review.com/article/the-scent-of-flavor#endnote-49)

On a whim, I used the data we had gathered to explore a different question: which constituents were contributing to sweetness? To my amazement, flavor—retronasal perception of the volatiles—was contributing substantially to sweetness. Checking individual volatiles identified those responsible.[50](https://inference-review.com/article/the-scent-of-flavor#endnote-50) A cherry tomato called “Matina,” for example, contained less sugar than another called “Yellow Jelly Bean,” but the Matina was about twice as sweet as the Yellow Jelly Bean. The volatiles that enhanced sweetness were more abundant in Matina.[51](https://inference-review.com/article/the-scent-of-flavor#endnote-51)

We then moved on to strawberries,[52](https://inference-review.com/article/the-scent-of-flavor%22%20%5Cl%20%22endnote-52) oranges,[53](https://inference-review.com/article/the-scent-of-flavor#endnote-53) and peaches. Each fruit produced a mostly new and different group of sweetness-enhancing volatiles, yielding almost 100 volatiles in total. One exception was blueberries, which contained very few volatiles that enhanced sweetness.[54](https://inference-review.com/article/the-scent-of-flavor#endnote-54) When you taste sweetness in a blueberry, you are essentially tasting the sugar. When you taste sweetness in the other fruits we studied, some of the sweetness is coming from the sugar, but a lot of it originates in the volatiles that enhance the sweetness of the sugar. In the early years of studying volatile-enhanced sweetness, none of us had realized that some fruits contain many such volatiles. Each one may produce only a small effect, but the effects are cumulative.[55](https://inference-review.com/article/the-scent-of-flavor#endnote-55)

Future Applications

**SWEETNESS-ENHANCING volatiles** are naturally found in fruits, but adding these volatiles to any food or beverage will add sweetness. Incidentally, sweetness-enhancing volatiles also work on artificial sweeteners. The concentrations of many sweet-enhancing volatiles in fruits are very low, making them a safe alternative to sugars and artificial sweeteners. Since the volatiles that enhance sweetness tend to be different in each fruit, the study of additional fruits will likely add to the list of those already identified.

Noam Sobel and his team have demonstrated that olfactory mixtures behave like mixtures of colored lights.[56](https://inference-review.com/article/the-scent-of-flavor#endnote-56) Combinations involving odorants of equal perceived intensities suppress one another resulting in a weak olfactory sensation they called “Laurax”—not to be confused with the famous Lorax described by Dr. Seuss. Laurax was also called “olfactory white” to emphasize its similarity to the white light that can result from color mixtures. In the terminology of Kubovy and Van Valkenburg, these are examples of eliminative emergence. This raises an interesting question: as we combine more and more volatiles that enhance sweetness, will their flavors cancel each other out while the sweetness increases? If so, volatile sweetening will have even more commercial applications.

**The ability of volatiles to enhance taste is not limited to sweetness.** A different group of volatiles enhance saltiness and are under study for their potential to reduce dependence on sodium.[57](https://inference-review.com/article/the-scent-of-flavor#endnote-57) A few volatiles have also been identified that can enhance sourness and bitterness.[58](https://inference-review.com/article/the-scent-of-flavor#endnote-58) This may tell us more about how this enhancement occurs in the brain, but these volatiles are unlikely to have as many applications as those that enhance sweetness and saltiness.

Volatile-enhanced tastes are also exciting for their clinical potential. Shortly before the COVID-19 pandemic began, I evaluated a patient who retained normal olfaction but had a reduced ability to taste sweetness. Adding sweetness-enhancing volatiles to sucrose allowed her to perceive normal sweetness. The sweetness-enhancing volatiles created a signal in her olfactory nerve that traveled to the area of the brain that processes sweetness, bypassing her damaged taste nerves. In theory, when we have identified enough taste-enhancing volatiles, we should be able to restore at least some taste perception to patients with taste nerve damage and intact olfaction.

Our love of sweet and salty tastes is at least partly hardwired into our brains. This source of pleasure is important in our lives. The interactions between the distinct sensations of taste and flavor have given us new tools to safeguard those pleasures **while reducing our dependence on sugars, artificial sweeteners, and sodium.**

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