The pleasure evoked by food attracts both scientists and artists. In the Presidential Symposium at the upcoming APS Convention in May, experts from both worlds will share their insights about why we love spices. Here, I’ll trace what we know about the story of spice, highlighting the roles of our fascinating convention speakers.

The anatomy of spice perception involves illusion. We seem to perceive spices both with the senses of taste and smell, but in reality, smell does most of the work. Consider cinnamon, an ancient spice (the first spice mentioned in the Old Testament). Even with our eyes closed, the smell of freshly baked cinnamon rolls grabs our attention. Sniffing draws the cinnamon volatiles (chemicals that evaporate at low temperatures and make their way into our nostrils as vapors) up into our noses; the volatiles pass through a tiny opening at the top of the nasal cavity called the olfactory cleft. When odorants pass through the cleft, they gain access to the olfactory mucosa, the tissue that contains olfactory receptors. This process is technically called “orthonasal olfaction,” but we commonly call it “smell.”

But there is a second kind of olfaction. When we bite into a cinnamon roll and chew and swallow, the cinnamon volatiles are forced up behind the palate into the nose; because of the backward route by which the volatiles enter the nose, this process is called “retronasal olfaction.” The combination of taste (sweet, salty, sour, bitter) and retronasal olfaction is called “flavor.” Note that we do not use “flavor” as a verb to describe our perceptions of flavor in the same way we use “taste” as a verb to describe our perceptions of taste. To flavor food means to add flavor to food rather than to perceive the flavor of food. But this does not bother us because we use “taste” in everyday conversation to refer to our perceptions of flavor. One of the reasons that we do not notice this linguistic slip is because flavor is perceptually localized to the mouth. This trap caught even Aristotle. He listed olfactory sensations perceived from food in the mouth as tastes.

Why do we experience this illusion of localization? We are not sure, but we know that touch and taste both play roles. The brain knows the route by which an odorant gets to the olfactory receptors. Sniffing may provide the cue that says “orthonasal olfaction.” Oral touch and taste sensations may provide the cues that say “retronasal olfaction.”

In any case, olfactory information goes to different brain areas and is processed in different ways depending on which route was detected. For example, retronasal olfaction can be intensified by taste. Food companies make good use of this intensification. If you market a beverage like grape juice and you would like to intensify the grape flavor of the juice, just add sugar (another reason why we are bombarded with sweetened drinks). Incidentally, supertasters, those individuals with the most taste buds, perceive the most intense tastes, and because of the connection between taste and retronasal olfaction, supertasters also experience the most intense flavors (Bartoshuk et al., 2004).

Current thinking is that the pleasure we experience from spices is learned. Cinnamon produces pleasure
because it was previously paired with experiences our brains are programmed to view favorably (e.g., calories, sweetness of sugar). On the other hand, pair cinnamon with nausea and it will become unpleasant. One of the volatiles in cinnamon, eugenol, is also found in cloves. Cloves and cinnamon do not smell exactly the same, but their odors are similar. Oil of cloves is a natural analgesic and was used by dentists in an earlier era. I associate the odor of cloves with sickness associated with visits to my dentist; I do not share the enthusiasm of those lined up at Cinnabon for the overpowering scents of those calorie-rich rolls. Incidentally, the degree to which learning with one kind of olfaction generalizes to another is not yet clear. Love of cinnamon is learned through retronasal experience but clearly generalizes to cinnamon sniffed. On the other hand, some odors are pleasant with one kind of smell (e.g., cut grass is pleasant when sniffed) but not with the other (I can’t imagine a cut-grass flavor).

The person most responsible for explaining how we learn to love or hate flavors is Paul Rozin (http://www.psych.upenn.edu/~rozin/), who will be joining us at the Presidential Symposium. Born in Brooklyn, Rozin got a BA from the University of Chicago and a PhD in Biology and Psychology working with Jean Mayer at Harvard. He has been at the University of Pennsylvania since 1963.

As noted in my first presidential column, Rozin described the “omnivore’s dilemma.” Somehow species like humans (and rats) that consume a large variety of different foods must take in important nutrients and avoid poisons. Rozin and his students have revealed how we do it (Rozin & Hormes, 2009). Our brains note the effects a given food has on us and make us like or dislike the sensory properties of those foods according to its notion of what is good or bad for us. For example, suppose we want to create a food item that will have great appeal. Begin with sources of calories (fat, carbohydrates), add sugar (for its hard-wired effect), and label the mixture with a salient odorant that will endow the item with a retronasal olfactory punch: I give you a brownie. On the other hand, let’s watch an undergraduate on his first alcohol binge get violently ill on screwdrivers. He will likely find screwdrivers distasteful the next day (and possibly for life). Further, the aversion may generalize to orange juice, orange candy, and a lot of other substances flavored with orange. The power of such conditioned aversions has even been used clinically to treat alcoholism (Lemere & Voegtlin, 1940).

By the way, the fact that the affect evoked by odorants is learned is what makes aroma therapy so hard to swallow for experts. Aroma therapy treats odors as if the affect they evoke is universal; this is not so. But before dismissing any possibility of innate affect for odors, let’s take a brief look at the science. Lipsitt (the father of human infant experimental psychology) and Engen (the father of modern olfactory psychophysics) collaborated to explore the affective reactions to odorants in one and two-year olds (Engen, 1982). The children, seated on their mother’s laps, were allowed to play with toys on a table in front of a picture with holes in it. While the child was engaged with a toy, an odorant was sprayed through one of the holes, and the child’s reaction was rated as pleasant, neutral, or unpleasant by observers in another room viewing the experiment through a one-way mirror. Two odorants were tested that are pleasant to most adults: amyl acetate (pears) and lavender. (To be honest, I don’t know how to describe lavender odor. It’s sold as a spice so there are samples in supermarkets. I suggest you try it.) Two odorants were tested that are unpleasant to most adults: dimethyl disulfide (garlic-like) and butyric acid (vomit-like). There were no significant differences in the reactions of the children to the four odorants. However, by age three, children begin to show preference reactions like those of adults (Engen, 1982; Schmidt & Beauchamp, 1988). The lack of affect at two years along with the appearance of affect over time supports the learning of olfactory affect.
But another issue has yet to be considered: biological benefits of spices. Flavor volatiles in many of the plants we consume are derived from important nutrients; thus, those volatiles could serve as cues to the presence of those nutrients (Goff & Klee, 2006). Further, the subset of plant volatiles that we call spices have been explicitly associated with health benefits. Interest in spices as antimicrobials led to a widely cited review in 1998 (Billing & Sherman, 1998). One of the most studied spices, turmeric, is associated with antioxidant, anti-inflammatory, and anti-cancer properties (Bengmark, Mesa, & Gil, 2009).

Not surprisingly, health benefits of spices have been a focus of attention for McCormick Spices (http://www.mccormickscienceinstitute.com), the home of one of the speakers in our symposium, Marianne Gillette. Gillette got an MBA at the University of Baltimore and MS and BS degrees in Nutrition Science at the University of California, Davis. She joined McCormick (the largest single spice seller in the world) in 1977 and has been involved there with sensory testing, industrial marketing, product development, and research and is currently Vice President, Technical Competencies and Platforms. She is also the current President of the Institute of Food Technologists, a scientific society founded in 1939 that currently has 22,000 members working in food science, food technology, and related professions in industry, academia, and government.

The health benefits of spices suggest that we reconsider the possibility of hard-wired liking of at least some spices. For example, is it possible that during evolution some of our ancestors began using turmeric? If turmeric prolonged their lives could this have ultimately contributed to the proliferation of turmeric-likers?

The art of spice usage leads to our next speaker: Mimi Sheraton (http://www.starchefs.com/MSheraton/MSheraton.shtml). The power of our attraction to food makes the activities associated with food an art as well as a science. Mimi Sheraton documents that art. She studied marketing and journalism at New York University and has written about food for a variety of magazines and newspapers. Perhaps her most famous food beat was as restaurant critic for the New York Times from 1976 to 1984. She has written 15 books including her latest, a memoir, “Eating My Words: An Appetite for Life” (Sheraton, 2004). She told me, “I have always equated combining spice flavors with mixing colors … a bit of this to change hue and tone, … a few drops of water or vinegar to make room for more flavors.” Sheraton is particularly interested in how the use of spices marks demographic shifts in population due to immigration. For example, zatar was unknown in the United States until it “fused into American-Continental cuisine as a seasoning for barbecued steaks and other meats.” She will share other examples of fashion shifts in the world of spices.

Harold McGee, another speaker at the symposium, is also moved by the art of foods (he is an expert on the “molecular gastronomy” that is producing new food processing techniques as well as new and fascinating culinary constructions), but he is most famous for drawing back the curtain and revealing the chemistry behind what we do in our kitchens. McGee got his BS from the California Institute of Technology and his PhD in English Literature from Yale University. His wrote his first book, On Food and Cooking: The Science and Lore of the Kitchen in 1984 then published a greatly revised edition in 2004 (McGee, 2004). McGee was cited as one of Time Magazine’s top 100 most influential people in the world in 2008. Alton Brown wrote the citation for McGee stating, “Whereas Julia Child taught ‘how,’ McGee explains ‘why.’” McGee currently writes a column for the New York Times: “The Curious Cook.” On his website (http://news.curiouscook.com), McGee reviewed efforts to find the origin of the burn of chili. He cited work suggesting that higher altitudes seems to produce chilis with
greater burn, possibly because the climate at those altitudes may stress the plants, which might make the chilis more vulnerable to attack (Tewksbury, Manchego, Haak, & Levey, 2006). Since the burn appears to act as a deterrent to predators, the increase in burn may better repel those predators. This attention to the burn of chilis is a reminder that burn (produced by capsaicin) is a part of what we think of as spices, but it is not a retronasal olfactory sensation; rather, burn is mediated by the trigeminal nerve (which also mediates temperature and touch sensations). Note that the oral burn that probably originated to repel predators can be transformed into a positive sensation in humans. Rozin recently commented that, “many innately negative stimuli … become highly desired and emerge as really important foods.”

How does this “hedonic reversal” occur? Some have argued that the biological benefits of chilis (e.g., antimicrobial properties, presence of vitamins A and C) somehow lead to our love of them. Whether or not this is so, children in cultures where chilis are an important part of the diet appear to learn the preference socially; that is, chili initially takes on positive value by association with intake by family and friends. Interestingly, it has proved difficult to induce animals to acquire a preference for chili. Rozin noted that some pets can acquire the preference through the social interaction of pet and owner, but attempts to condition preferences for chili in most animals have met with only modest success. However, one of Rozin’s students, Bennett Galef, was able to condition a mild preference for chili in naïve rats socially by exposing them to rats that had eaten the spice (Galef, 1989).

We hope to share some flavor/spice experiences during and after the symposium, and further hope our shared experiences with spices may contribute to acquisition of new pleasure from them.